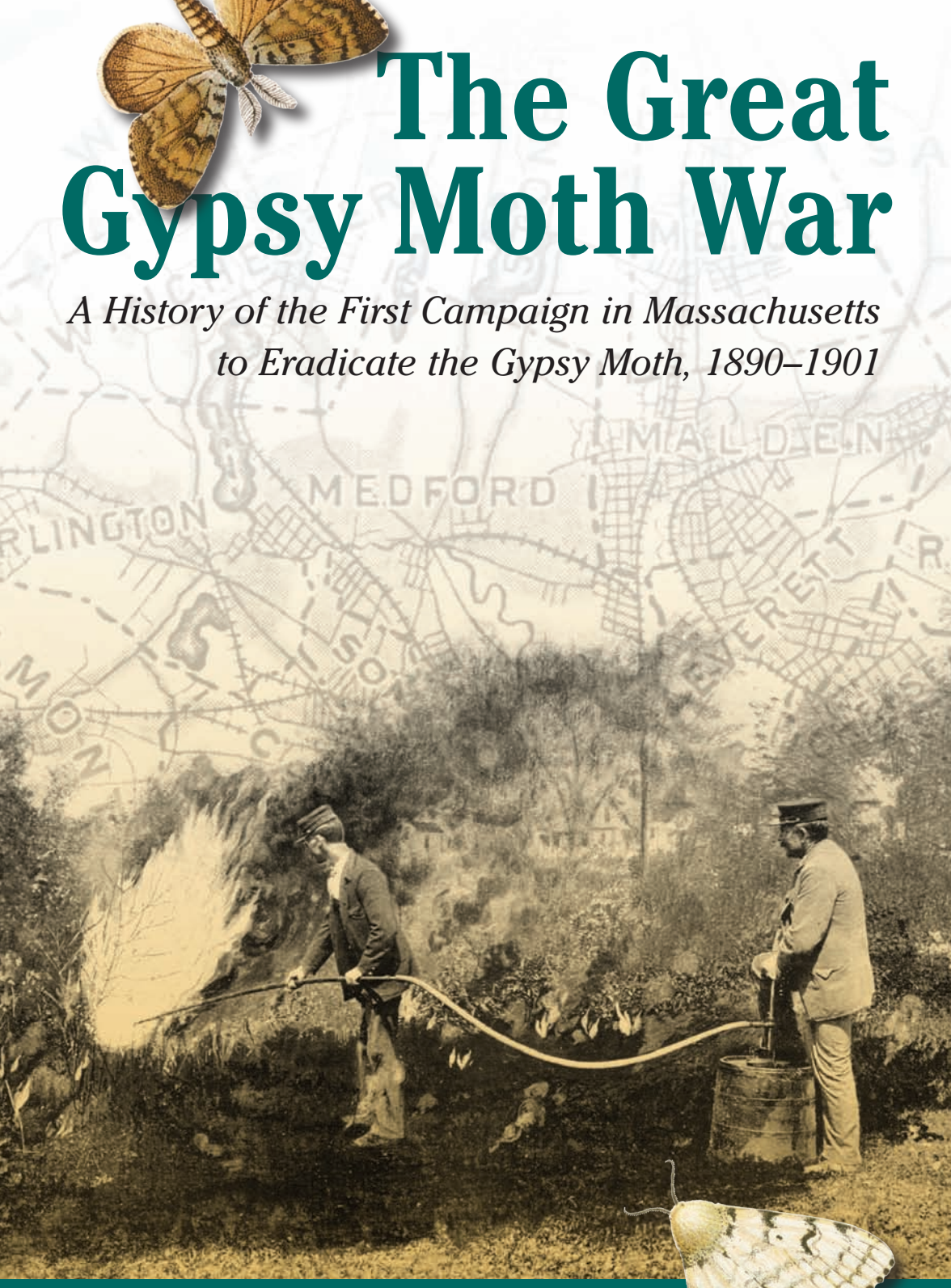
The Great Gypsy Moth War

A History of the First Campaign in Massachusetts to Eradicate the Gypsy Moth, 1890–1901



ROBERT J. SPEAR

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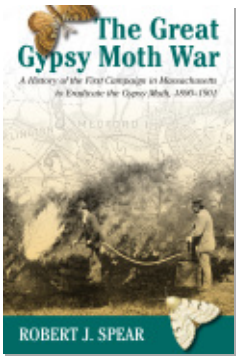
Spear, Robert J.



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The Great Gypsy Moth War

The History of the First Campaign in Massachusetts to Eradicate the Gypsy Moth, 1890–1901

Robert J. Spear

University of Massachusetts Press
AMHERST AND BOSTON

To Deena

O wad some Pow'r the giftie gie us
To see oursels as others see us
It wad frae monie a blunder free us
An' foolish notion
What airs in dress an' gait wad lea'e us
An' ev'n Devotion

—Robert Burns, "*To a Louse on seeing one on a lady's hat at Church*"

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Preface

Work on this book began in 1994 at my home, then located in Accokeek, Maryland. The impetus for my efforts was the constant spraying for the gypsy moth that drove my chemically sensitive wife and me out of our home every year around Mother's Day. I began to distribute a newsletter called *Gypsy Myths* to my community, and my research for this publication subsequently served as the basis for the additional research that is presented in this book.

I was fortunate to find a few surviving documents that were a researcher's dream come true: eyewitness accounts of events that often allowed me to let the story be told by the people who lived it. I have left these recountings largely as I found them—grammatical errors, colloquial expressions, and all. Where I felt the need for clarification, I have enclosed it in square brackets to distinguish it from any parenthetical passages in the original. Most of the photos and other graphic material come from *The Gypsy Moth*, the epic monograph by Edward Forbush and Charles Fernald. The originals from which the plates were derived are long gone.

With regard to citations for personal correspondence and unpublished material, I have tried to be specific about where these are located, including library call numbers and the box and folder numbers of archived collections, in the hope that this information might be of some use to other researchers. This detail is sometimes absent from the Boston Society of Natural History Archives at the Lyman Library because Lyman's holdings had not been catalogued at the time I did my research there.

I recall with fond memories all those whose help and assistance were freely given to me during the years this book was in preparation and express my gratitude to them here both collectively and individually. The libraries of some of our great educational and governmental institutions have been a source of much of the basic factual data incorporated in this book, and among the treasures found in these places are the librarians and archivists themselves—the people who so faithfully maintain the great repositories of our history and

make them available in good order to the researcher. I think it would be hard to find a more sincere, supportive, and helpful group anywhere, and every one of them without exception went well beyond the call in helping me with my explorations.

My off-line research began at the Comstock Memorial Entomology Library at Cornell University in my beloved home city of Ithaca, New York, where chief librarian Marty Schlabach and his assistant, Benjamin W. Fierce, welcomed me to the world of highly obscure publications of considerable age in stacks that rolled on wheels. I also was courteously received at Cornell's Mann Library, Olin Library, and the Cornell University Library Annex (yes, next time I will bring my own M&Ms).

Thanks also to Michael Milewski, senior archivist of the Special Collections and Archives Section, and Leonard Adams of the Government Documents Department, W. E. B. Du Bois Library at the University of Massachusetts Amherst. Their work behind the scenes made every hour I spent in Amherst unusually productive. I also thank Mike's wife, Heidi, whose wickedly good Polish galumpkis and New England hospitality were a welcome respite from five nights of thin cheeseburgers.

My thanks also to Elizabeth Marzuoli, reference archivist at the Massachusetts State Archives, Dorchester, for bringing out mountains of heavy book boxes for me to peruse and remaining cheerful even when I asked for the wrong ones. Sean Fisher, archivist and historian for the Metropolitan District Commission (successor to the Metropolitan Park Commission mentioned in this book), provided many relevant materials even before I knew to ask for them, earning both my gratitude and my admiration.

Mark C. Scott, reference librarian at the Massachusetts State House Library in Boston, astutely guided me through arcane indexing systems to the treasures they reference. Special thanks as well to Betsy Lowenstein, chief, and Christine Gebhard, preservation assistant, of the Special Collections Department there, whose kindness to a stranger included some much-needed extra time in the reading room and repairs on the fly to fragile old documents so they could be copied before I left.

I have been cordially received at a number of local public libraries and historical societies. The assistance and contributions of Richard A. Duffy and Bill Mahoney, trustees of the Arlington Historical Society in Arlington, Massachusetts, greatly aided my initial research. Particular thanks go to the reference librarians at the public library in Medford, Massachusetts, the entomological ground zero of this book, who prefer to be recognized as a group.

Philip J. Pauly of Rutgers University, professor of history and a man of considerable patience, was steadfast in his encouragement of my project, directed me toward a number of rewarding sources, and left me a much better

historical sleuth than I had been before we met. Special thanks also to Edward H. Smith, professor emeritus of entomology at Cornell, for his important observations, suggestions, and continued support. Also among those who helped me through the research doldrums were Mary P. Winsor of the Institutes for the History and Philosophy of Science at the University of Toronto, and Pamela Henson, historian at the Smithsonian Institution.

Considerable assistance through long-distance research was given by archivist Robert Young at the Museum of Comparative Zoology, Harvard; Robert Cox, American Philosophical Society, Philadelphia; William Cox, associate archivist, the Smithsonian Institution, Washington, D.C.; Carolyn Kirdahy, curator of objects, Museum of Science in Boston (successor to the Boston Society of Natural History); Ellen Mann, special collections, National Agricultural Library, Beltsville, Maryland; and Nick Natanson, National Archives and Records Administrations, Washington, D.C.

My sincere thanks to those I conscripted to read my manuscript to eliminate factual errors, make comments, and help me clarify areas that needed it (and there were many), among them, Philip Pauly for general historical accuracy; Edward Smith for entomological accuracy and sections on C. V. Riley; Sean Fisher, archivist and historian of the Metropolitan District Commission for sections on the Park Commisioner; Alexander F. Thornhill, whose only failing was to be my loyal friend, for typographical errors caught; and Deena Spear, my patient and long-suffering spouse, for her loving encouragement even though there must have been times when she questioned my sanity.

I conclude by expressing my appreciation and regard for Bruce Wilcox, director of the University of Massachusetts Press, for his confidence in my book and helping me to get the work published during extremely difficult financial times; Carol Betsch, managing editor, for her endless patience, inexhaustible good will, and gentle hand; and copy editor Patricia Sterling, who possibly understands the manuscript even better than I do!

Introduction

On January 1, 1896, a committee on gypsy moths of the Massachusetts State Board of Agriculture published its monographic report, *The Gypsy Moth, Porthetria dispar (Linn.): A Report of the Work of Destroying the Insect in the Commonwealth of Massachusetts, Together With an Account of Its History and Habits Both in Massachusetts and Europe*. Today this volume of nearly six hundred pages, with its thick appendixes, numerous plates, and drawings is referred to simply as *The Gypsy Moth*. Edward H. Forbush, director of fieldwork against the moth, and economic entomologist Charles H. Fernald, a professor of zoology at the Massachusetts Agricultural College and adviser to the committee in charge, each wrote about half of the report, with help from Fernald's assistant, Archie H. Kirkland, and entomologist Samuel Henshaw of the Agassiz Museum at Harvard.

The Gypsy Moth, a history of the first half of the first campaign to exterminate the insect, is a tale told the way Forbush and Fernald wanted to tell it. The text celebrates the belief of economic entomology in itself and its champions, who waged the war under damaging handicaps, although many of their wounds turned out to be self-inflicted. The tone of the volume is so unremittingly assured that even a hundred years later one writer referred to it as "a hymn to the belief that knowledge is ammunition," characterized its authors as scientific zealots, and described its philosophical underpinnings as a "testament of obsession."[1]

It is from this work alone that almost all of what is now believed about the campaign to exterminate the gypsy moth has been drawn, which may prove the thesis that history is not always what happened. Economic entomologists and their historians generally have tended to advance the idea that the insect was nearly wiped out and victory within reach, and that the campaign failed because of an irrational act of the Massachusetts legislature in discontinuing annual appropriations. New research shows that this was not quite the case.

During the latter half of the nineteenth century, the time in which this story took place, great changes were sweeping the country. Colleges and universities were converting from religion-based institutions of rote learning into modern

secular schools of scientific training and practical application. The promise of technology beckoned, but the hold of theological assumptions was still strong. In the field of natural sciences, the ideas of Darwin, Huxley, and Spencer emerged to dominate, though not replace, the older ideas of divine or "special" creation. Scientific men of the time wavered between these two mighty and often conflicting forces. Strange juxtapositions temporarily existed; amid transitions and tensions, the journey into the new century did not proceed smoothly.

The decade of the 1890s was marked by social, political, and economic turmoil on a scale some historians believe was not matched even by the turbulent decade of the 1960s. The events described in this book occurred at a time when the assets of both men and nature were being plundered in a way and at a pace that had never been seen before, when the very resources of the earth first revealed their limits, and when many species of animals began to live on the edge of extinction. Also rising in this time were the ideas and philosophies of conservation, ecology, replenishment, and protection of a finite biosphere, all contending strongly for acceptance.

Entomology, a young field that was also in transition during the late nineteenth century, was still dominated by amateurs and men who were either self-taught or whose college degrees were in other subjects. The study of insects was roughly divided between two groups: the taxonomists (also called systematists), who discovered insects, named them, described their features, put them in order, and catalogued them; and the agriculturalists, who studied the life cycles of damaging insects, especially in the larval stage, and made recommendations to farmers on how best to protect their crops. Entomologists found employment wherever they could, for their opportunities were not extensive at the time. Although all practitioners took nets into the field, in the 1890s taxonomists and systematists worked primarily in museums and educational institutions, whereas agriculturalists spent most of their time at a few colleges or in government offices.

Agricultural entomology was redefined by the formal emergence of a new applied branch called economic entomology, which occurred, by a fateful coincidence, during the summer of 1889—the same summer in which great swarms of gypsy moths first began to plague eastern Massachusetts—following the establishment the year before of agricultural experiment stations. The rapid change in this science from a classical to a practical orientation proceeded with great difficulties and some monumental missteps, and the first of these was the war against the gypsy moth.

The accidental release of the European gypsy moth (*Bombyx dispar*) in Medford, Massachusetts, on a windy spring day in 1869 was, of course, an entomological event, but it was also a historical event, although mention of

the campaign against the insect will not be found in any general history book. The story of this particular war is relegated to scraps of information scattered in local historical societies, newspaper archives, and university libraries, and to a few rather obscure documents from government agencies such as the old Massachusetts State Board of Agriculture or the bureau of entomology of the U.S. Department of Agriculture (USDA) in its earliest years. Because the facts of this war remain sprinkled here and there in bits and pieces and are strikingly absent from most of the history of economic entomology, their importance has been diminished, and the lessons to be learned from them have been obscured.

What these lessons were (or should have been) will likely remain a subject of debate. In the broadest sense, the history of the gypsy moth campaign serves to remind us that we have not yet found a good response to invasive insects and continue to resist the notion that there may not be one. It also questions the supposition of expertness freely granted those who claim to have the knowledge to guide us through extermination campaigns, even though their voices may be used to mask other elements and interests.

Although this book will not entirely resolve differences of opinion on these points, it presents additional information that will perhaps enable the reader to draw new conclusions. It examines the gypsy moth war from a historical as well as an entomological viewpoint. The manner of the moth's introduction, the course of the war against it, and the reasons for the war's failure have become a matter of lore and misconception. Lacking an understanding of the conditions and underlying causes of the moth's success, campaigns against the insect ever since have largely followed the flawed Massachusetts model. Indeed, practically all insect eradication campaigns have their roots in this epic.

The gypsy moth war is distinguished from any war this nation has fought against human adversaries because the hostilities have never ceased, and the insidious consequences of more than a century of unremitting warfare—and its continued heavy impact on both the environment and the daily lives of every American—have gone unrealized. In our time we have come to think of battles against insects as a long and ancient part of our history, but few realize how modern the practice is as presently carried on, and even fewer have understood how dangerous it has become.

The decision to treat the discovery of concentrated colonies of gypsy moths as a grave danger to Massachusetts in particular and the country in general was based in part on the need felt by economic entomologists of the time to prove the worth of their new discipline, and in part on the twist of fate that caused the insect to appear in Massachusetts, then the only state in the nation that would make large appropriations to exscind the invader within its boundaries.

Anthropologist Margaret Mead's famous saying that a small group of dedicated individuals is the only thing that has ever changed the world was never truer than during this tumultuous period when just six unlikely men, for varying reasons that are set forth in the text, devised, executed, and lost the first war against the gypsy moth. These were Nathaniel Southgate Shaler, a Harvard professor and dean of the Lawrence Scientific School; Charles Valentine Riley, chief in entomology at the U.S. Department of Agriculture; Leland Ossian Howard, Riley's assistant and successor; Charles Henry Fernald, entomologist and professor of zoology at the Massachusetts Agricultural College; Edward Howe Forbush, an ornithologist who became the state superintendent of fieldwork against the moth; and William Robert Sessions, a former politician and secretary of the Massachusetts State Board of Agriculture. These men would be considered historical small fry, forgotten bit players in the theater of American life, had their actions not profoundly changed the course of history.

The entire field of science changed in the nineteenth century as the age of the generalist ended and the age of the specialist began. British author Doron Swade has commented that the first half of the nineteenth century was the last period in history when it was possible for one man to know all there was to know about every science, when securing an all-encompassing knowledge was "an aspiration and not an affectation."[2] Many of the principals of this book were born in the first half of that century, and a few still pursued the idea of acquiring an encompassing knowledge. Men such as Shaler and Fernald possessed formidable intellectual capacities that they applied to an extraordinarily broad range of interests, although Forbush, Sessions, Riley, and others had only secondary school educations. Fernald and Riley were self-trained in entomology; Shaler was principally a geologist; Forbush dropped out of school to become a taxidermist and a mechanic; Sessions was a farmer turned politician; and Howard was a federal bureaucrat who had hoped for a career in medicine. Others on the state's gypsy moth committee were businessmen and merchants with no agricultural or entomological credentials at all. No committeeman was expected to devote more than one or two evenings a month to this task, even though it was a task that no other state agency in America had ever attempted.

Riley was removed from influence by the vagaries of federal politics and an untimely accident, and Shaler removed himself for personal reasons, both men departing midway through the campaign, leaving Fernald, the most respected agricultural entomologist in Massachusetts, to gain unprecedented power in planning the battle. Forbush prosecuted his wishes with unyielding determination. Sessions, a canny veteran of Massachusetts political life, pushed the complementary goals of economic entomologists and the Board of Agriculture through the state legislature, using his great skill in political manipulation.

Members of the committee seem to have simply followed everything their entomologist told them to do. The concerns of other scientists over the scope of the campaign, the concerns of legislators over its cost, and the concerns of the public over its dangers were all swept aside.

All of these men were manipulating various niches and conditions in the rapidly changing world of the 1890s for reasons that were not alone concerned with the destruction of a formidable insect invader. Their success in promoting themselves occurred in part because all elected officials in Massachusetts then served one-year terms, and all were constantly running for reelection.[3] Turnover was markedly high, and the level of experience in state government was correspondingly low. The administrative duties of the state were commonly delegated to unpaid volunteer boards or low-paid, part-time commissions of citizens who, like the legislators, were inexperienced and constrained to rely on the advice of experts of questionable competence, merely rubber-stamping what was given to them.

Even the structure of government was not comprehensive enough for the task. Since the state had no foresters or forestry bureau (the office of state forester would not be created until early in the next century), the care of forests was placed under the Board of Agriculture, whose members regarded timberlands as a sow-and-reap system and who were concerned not with the ecology of wooded land but with its economy. Under these conditions, power fell into the hands of an immature bureaucracy, and a small group of economic entomologists and their supporters suddenly found themselves wielding a great deal of authority to undertake a task for which they were almost completely unprepared—the first attempt anywhere to field a publicly funded army of men and equipment to assault a foreign insect and destroy it completely within three years.

New England forests at the time this narrative begins included second-growth hardwood stands that had replaced a forest with a large component of softwood. From antiquity, the great mixed woodland of the region had contained vast tracts of white pine in the southern and central sections mixed with spruce and fir in the north. After the arrival of Europeans, these stands had been heavily logged for commercial purposes, and much acreage in Massachusetts was cleared entirely of both hardwoods and softwoods to make it suitable for farming; by 1880, more than 80 percent of the state's forests had been cleared. But with the population in a steep decline as farmers gave up on the region's thin, rocky soil, abandoned their farmsteads, and moved to the more fertile lands of the Midwest, trees immediately sprang up on the deserted farmland.[4]

The new forest seems to have been different from the old and was dominated by opportunistic species such as oak. Fire burned through substantial

portions of Massachusetts and neighboring Rhode Island several times during the eighteenth and nineteenth centuries, and since the oaks were more resistant, owing to their thicker bark, they remained the dominant tree in many regions.[5] Oaks reclaimed burned or logged-over areas faster because they grew well in poor soils, tolerated shading better, and sprouted off the stump, whereas softwood species required richer soil, grew poorly in the absence of sunlight, and renewed only from seed. The introduction of the gypsy moth and the massive human interference that accompanied colonial expansion proved to be an unfortunate coincidence. The forests of Massachusetts always would have been vulnerable to the gypsy moth, but the insects escaped into an environment that had only recently come to contain a high percentage of the very hardwood tree that was most attractive to them.

All of what has been described above was a powerful undercurrent rushing beneath a calmer surface that might seem unremarkable to the modern eye. The last decade of the nineteenth century was probably the first decade in the history of America when a visitor from the present time might feel in familiar surroundings. Houses in populated areas had begun to have central heating, sanitary plumbing, and electricity, and telephones were coming into general use. Steel-hulled steamships plied the oceans, and fast trains crossed the countryside. The automobile was about ready to take to the road, and the airplane would soon rise above the horizon. People in the suburbs were taking jobs in the cities and commuting to work.

The first two chapters of this book cover the arrival in Cambridge, Massachusetts, of E. Leopold Trouvelot and illuminate his efforts to establish himself as a breeder of an improved silkworm, which led to the importation and release of the gypsy moth in America. Trouvelot's story is not well understood, and his role deserves reappraisal. The next three chapters deal with the overpopulation of gypsy moths and to what might be termed "false starts" in managing the resulting real and imagined problems.

The remainder of the book follows the efforts made to control, contain, and kill the invaders, whose ability to survive caused proponents of the war against them to cross the line in an effort to achieve their aims. By the middle of the war, almost all economic entomologists knew that eradication could not be attained, yet they continued to urge the Commonwealth of Massachusetts to pour increasing amounts of money into the conflict on the basis of their statements as scientific men that the goal was within reach. Not above manipulating the state legislature to attain their ends, in effect they perpetrated a fraud on the Commonwealth. Or perhaps they were not conspirators in the usual sense but just overly zealous in their desperate fight to retain their jobs and protect their credibility and reputation. Readers will have to decide for themselves.

[CHAPTER 1]

Years in the Shadow of Science

THE GREAT GYPSY MOTH WAR began in 1890, but the story starts thirty years earlier, when Etienne Leopold Trouvelot left Europe for Boston, Massachusetts. Trouvelot was born on December 26, 1827, in Guyencourt, Department of Aisne, France. His education and upbringing remain a mystery, but many traits he manifested later in life suggest that he must have been an intelligent and talented student. He was a gifted artist, illustrator, lithographer, and engraver, and the levels to which his skills were developed imply that he had been provided with the best professional instruction. Among the benefits of a nineteenth-century training in art would have been the honing of his powers of observation, necessary for the accurate rendering of subjects in nature.

Little is known about the man, his private life, or his family. Were it not for the astronomer Edward S. Holden, who began a personal photographic collection of his colleagues and other scientific men in the 1890s, posterity would not have even a single photograph of Trouvelot. Though Holden's picture reveals the lines of age setting in around his eyes and shows the first streaks of gray in his hair and beard, his face retains an appealing, boyish quality. Many others have tried to draw his personality from this picture and have concluded that he was a dreamy, wistful romantic or in some other way disconnected from the practical concerns of average mortals.

No one who worked in the natural sciences, however, as Trouvelot did, could be so detached from the world around him. He had a quick and inventive mind, and his friend Nathaniel Southgate Shaler noted that he was "extremely experimental."[1] One suspects he was a gentle and kindhearted human being who thought of insects in a way that was almost romantic. He saw organization and admirable industry in the societies of ants and intelligence in the activities of a tiger swallowtail larva when he watched it roll up the leaf on which it was feeding to keep from being washed off by a heavy rain.[2] He worried that experiments in which an insect was mutilated would cause it pain or prevent it from finding food, and it saddened him to observe an insect

E. Leopold Trouvelot.

Photo courtesy of the Mary Lea Shane Archives of the Lick Observatory, University of California, Santa Cruz.

deprived of the company of its own kind. He wrote of one case where he had removed the antennae of a male *Promethia* moth and placed the handicapped creature next to a female: "The male Promethia had his sight; he could see near him another insect like himself, but his eyes alone could not tell him whether the insect was of the same species and of another sex, so he died near the object he would have desired if [his sense organs] had not been removed."[3]

The consensus is that Trouvelot came to America at the age of thirty, although it is not clear whether his decision was caused by unfavorable conditions in France or by opportunities in the United States. A few authors have suggested that he was a liberal republican and anti-Royalist who fled the Second Empire when the succession of the Napoleonic line was established in 1856 by the birth of Napoleon IV.[4] Others have speculated that he was forced into exile. There are, unfortunately, no surviving records from Trouvelot himself that would settle the matter.

Trouvelot seems to have been living in Paris at the time of his decision to depart.[5] He may have been there for employment or to study art, and he was possibly influenced by the great French naturalist and entomologist Felix-Edouard Guerin-Meneville, (1799–1874), who acted as a confidant or mentor of some sort; Trouvelot is known to have corresponded with him from the United States, and Guerin-Meneville also supplied Trouvelot with specimens of insects and the eggs of exotic silk moths. Guerin-Meneville was a naturalist in the old style with a broad range of interests, and he was the author and

publisher of journals and such illustrated and hand-colored works as his *Dictionnaire pittoresque d'histoire naturelle*, published in Paris between 1836 and 1839. He catalogued and named many creatures from all over the world, especially Crustacea (aquatic arthropods), Coleoptera (beetles) and Lepidoptera (moths and butterflies). Perhaps it was the influence of Guerin-Meneville and the artists who created the beautiful illustrations in his books that inspired a talented young man about to embark for the New World to combine natural history, entomology, and art as his life's work.

Trouvelot's obituary in *Nature* states that after the coup d'etat in 1852 he went directly to Cambridge, Massachusetts.[6] There seems to be no record of Trouvelot's whereabouts between 1852 and 1856, however, and there is no listing for him in either the *Cambridge City Directory* or the *Boston City Directory* during those years. His arrival in America, then, probably occurred at the end of 1856 or the beginning of 1857, given the birth records of his children: a son, George, was born about the time Trouvelot apparently reached Massachusetts; and on June 5, 1858, a daughter, Diana, was born.[7] Diana's birth record shows that Trouvelot's wife, Adelaide, called Adele, was born in France.

The record also lists Trouvelot's occupation as "lithographer," which indicates how he was earning an income in the United States, and for many years afterward he said that his pencil was his "only resource to support his family."[8] His skills were immediately appreciated, and he had "always a great deal to do in lithography, of very easy work."[9] Within a decade he commanded a fee of ten dollars a day at a time when an average factory worker was making less than twenty-five cents an hour. Trouvelot remained a man of modest financial means but independent enough to send his son to be educated at the Boston Latin School.[10]

Medford, Massachusetts

In 1857, Trouvelot took up residence in the small town of Medford, which is near to Cambridge and easily accessible from Boston. Founded in 1630 and located on the Mystic River in Middlesex County about five miles north and a little west of Boston, Medford is the fourth oldest English settlement in America. Its population was approaching five thousand at the time Trouvelot arrived.[11] He bought a new residence at 27 Myrtle Street directly from the builder,[12] and in the federal census for 1860 he gave the value of this property as $1,100. Trouvelot's dwelling was on the then-remote fringes of Medford's Glenwood district—an unofficial and unincorporated name that some documents refer to as "Middlesex"—which later writers characterized as "wild and wooded."[13]

Trouvelot House, 27 Myrtle Street, Medford, Mass., circa 1895.
From *The Gypsy Moth.*

Myrtle Street was nevertheless in a neat, working-class neighborhood where most of the residents owned their houses. E. W. Wood described it as being "occupied by mechanics" and said the wood-framed structures were built on small plots averaging about 12,000 square feet each. Most residents had food gardens, and many also had fruit trees.[14] The U.S. census for 1860 lists Leopold Trouvelot, age thirty-two, and his wife, Adelaide, age twenty-six, living on Myrtle Street in Medford with their two children, a boy age three and a daughter age two (though the children are incorrectly identified as "Stephen" and "Adelaide"). Trouvelot again gave his profession as "lithographer."[15]

The 1870 census shows L. Trouvelot residing in Medford with Adele, George, and Diana Trouvelot.[16] Adelaide's age is given as thirty-four; Trouvelot's is incorrectly listed as thirty-two. George and Diana are shown as fourteen and twelve years of age, respectively. Their father informed the enumerator that both his children were born in Massachusetts, making them U.S. citizens. He again gave his occupation as "lithographer," while his spouse was "keeping house," and both children were "at school."

Behind Trouvelot's new house was a south-facing lot variously given as five to eight acres in size. Edward Samuels recorded that Trouvelot's land was "surrounded with scrub oak and huckleberry bushes . . . loaded with fruit."[17] Just south and a little west was the intersection of Riverside and Spring Streets, and south of that the Mystic River, flowing from its source in the Mystic Lakes west of Medford, twisted its way through a salt marsh eastward toward the ocean. Trouvelot's house, one of the last on the block and one of the farthest

east of the town, was situated at a point where Myrtle Street angled away from the railroad tracks and entered about twenty undeveloped acres of scrub oak.[18]

Trouvelot and the Rise of Natural Science

It would be easy to assume that Trouvelot came to America to undertake silkworm research, since he was engaged in it almost immediately upon his arrival, and that he chose Boston because Massachusetts had a reputation as a state that actively fostered all aspects of the silk trade, following the efforts of sericulturalist Jonathan Holmes Cobb in the 1830s and 1840s. This scenario is not entirely satisfying, given Trouvelot's wide range of interests. These included astronomy, a field of study that overlapped his interest in entomology, and Harvard College in Cambridge was one of only a few American institutions that could boast its own astronomy facility. Between 1847 and 1867 its fifteen-inch Boyden refractor was the largest astronomical telescope in the United States. Leland Ossian Howard reported that by 1869 Trouvelot was connected with the Harvard Observatory and held the title of "professor."[19] Other evidence suggests that this date is ten years too early: Jan Herman and Brenda Corbin relate that Trouvelot did not begin an official association with the observatory until 1872, when his drawings of celestial events came to the attention of Joseph Winlock, the observatory's director.[20]

In any case, between 1850 and 1880, Massachusetts was the undisputed center of science in America, and Harvard College was the center of science in Massachusetts. The cause of Harvard's preeminence was the presence of the Swiss-born naturalist Louis Agassiz, who made Cambridge a beacon for those seeking knowledge.[21] When Trouvelot walked down the gangplank in 1856 or 1857, he found himself at the center of the greatest craze for the natural sciences in the century. Agassiz had proposed to write a natural history of the United States and everything in it and was turning everyone from farmers to fishermen from East coast to West into collectors of specimens. He was also selling advance subscriptions to his projected ten-volume work, *Contributions to the Natural History of the United States*. So intensive was the effort that as author Edward Lurie has put it, "If any literate individual in America or Europe failed to hear of Agassiz and the *Contributions* from 1855 to 1857, it was surely an accident."[22]

Concentrated at Harvard was a growing number of French-speaking Swiss who were engaged in this important work with Agassiz. In 1859, Agassiz and Asa Gray founded the Museum of Comparative Zoology (MCZ) at Harvard, an institution that was inundated from the start with more specimens than it had men qualified to describe and catalogue. To help in the work, Agassiz at

first employed a number of his American students and later some European professionals. Trouvelot ingratiated himself with this group, for the chance to be among those who spoke his native language and the opportunity to gain knowledge and experience would have drawn him as a lamp draws a moth.

Trouvelot even gathered specimens for the museum's collection, probably at the request of Agassiz or one of his assistants. In the annual report of the MCZ for 1863, museum assistant Addison E. Verrill recorded Trouvelot's donations of "six bird's nests and eggs, dry," and Frederic Ward Putnam acknowledged Trouvelot's contribution of five specimens and four species to the museum's reptile collection.[23] The annual report of the museum for 1864 records Trouvelot's second contribution of birds, eggs, and reptiles.[24]

Trouvelot would have become acquainted with people of influence at Harvard because he was there when many of them arrived. He met geologist Nathaniel Southgate Shaler, future dean of the Lawrence Scientific School, when Shaler was still a student, and he was there in 1867 when the German entomologist Hermann August Hagen first arrived in America. Trouvelot knew Samuel Henshaw, who was active in the Boston Society of Natural History and a cofounder of the Cambridge Entomological Society; he also knew the great fossil entomologist Samuel Hubbard Scudder, who was then Agassiz's graduate student; he likely met most of the talented young students who studied under Louis Agassiz or Herman Hagen, such as John Henry Comstock, Albert John Cook, Henry Guernsey Hubbard, Alpheus Hyatt, Edward S. Morse, Alpheus Spring Packard, Frederic Ward Putnam, Philip Reese Uhler, and Burt Green Wilder. Some of these men corresponded with him later on; some visited his outdoor insectary in Medford in the 1860s; and some asked him to write accounts of his work for popular publication.

If Trouvelot did not meet all these men at the MCZ, he mingled with many of them when he joined the Boston Society of Natural History, an organization whose membership included many distinguished New England naturalists. In 1867, Trouvelot read a paper titled "On Monstrosities observed in the wings of Lepidopterous Insects, and on the method of producing them artificially."[25] Notice of this presentation was published in the premier issue of the *American Naturalist* magazine. Another paper, published about ten years later, was titled "The Use of Antennae in Insects."

The picture that emerges of Trouvelot between 1857 and 1866 is similar to that of other autodidacts of his time who became versed in a wide variety of subjects in order to maximize their opportunities to advance their prestige and make themselves employable. The rise of the scientific disciplines in America had briefly opened a window of opportunity and placed almost all interested individuals on a near-equal footing, regardless of their training. Nowhere was this truer than in entomology, long considered a fringe discipline at best, in

which nearly everyone at the time was self-taught and even an amateur could make significant contributions.

Experiments with Silk Moths

Trouvelot seized upon silk moths as his potential pathway to scientific respect and financial reward. Howard states that Trouvelot "for his pleasure and interest was engaged in the study of wild silkworms with the idea that a species of commercial value might be found, and that perhaps something might be done in the way of cross breeding allied species, thus producing not perhaps a better quality of silk than that of the silkworm of commerce, but a hardier insect, which would require less artificial attention and at the same time would be more resistant to disease."[26]

Trouvelot was occupied with silkworm research for much of the time between 1859 and 1870, and possibly earlier, and he was interested particularly in the American Luna, Prometheus, and eye-spotted Cecropia moths. All of them were classified at the time as silkworms in the family Bombycidae, which leaves little doubt about where he was applying his efforts. In a series of articles he wrote for the *American Naturalist* magazine beginning in March 1867, Trouvelot stated that he had been studying American silk moths "for over six years."[27] Around 1860 he had begun concentrating his attention on what he called the "American silkworm," *Telea polyphemus*.

Once the Civil War began in 1861, the supply of cotton from southern fields was disrupted, and the textile mills of New England lay idle while the northern states looked elsewhere for raw fiber; thus a window of opportunity opened for those hunting fortune and new sources of silk. But Trouvelot's experiments with *Telea polyphemus* were undergoing a rather laborious beginning. He searched diligently for caterpillars in the spring of 1860 and found only two males. The next year he found twelve caterpillars and from their cocoons reared a single mated pair that produced three hundred fertile eggs. Of this number at the end of the third year just twelve insects survived to pupate, but by then Trouvelot had gained enough experience to ensure their survival, and the moths increased in number rapidly thereafter.

Trouvelot's experiments with silkworms were known to the scientific community in Cambridge, and over the years a small number of scientific men made the trip to Medford to see firsthand the work that he was doing. One of these was entomologist Alpheus Spring Packard, then just twenty-three years of age. Packard was preparing a synopsis of the American silk moths, which he published in 1865, and he later became a noted member of Charles Valentine Riley's Rocky Mountain Locust Commission. Packard believed Trouvelot began working with the gypsy moth five years earlier than had been thought:

"About 1862 I went out to Medford and saw Mr. Trouvelot; went over to his farm about the same time when this moth had unfortunately been brought to this country, although I did not know it at the time, as he did not mention the fact to me."[28]

According to Trouvelot's own account, he ultimately had no fewer than a million caterpillars, all of which were descended from the original surviving *T. polyphemus* pair of 1861, feeding behind his house on Myrtle Street. To contain his hordes of larvae he constructed a stupendous barricade to encircle his grounds—a wooden fence eight feet high that encompassed his full five acres of shrubs and small trees.[29] Netting was stretched from the perimeter of the fences across the trees, and was supported in the middle on posts, making it possible for Trouvelot to walk upright through his specialized insectary. Despite all his precautions, though, birds took a heavy toll on his investment; the mesh was too coarse and not in good repair, which allowed birds to get underneath. In 1866 he constructed a shed behind his house and transferred some of his moth-breeding attempts inside it, feeding the larvae by hand, though older caterpillars still had to be placed in the open under the netting. Sometime in 1865 or 1866, Edward A. Samuels, researching his book on the birds of New England, visited Trouvelot's silkworm farm: "Mr. Trouvelot, of Medford, Mass . . . has a tract of about seven or eight acres enclosed, and mostly covered with netting. He is obliged, in self defence, to kill the birds which penetrate into the enclosure and destroy the worms. . . . He says [the robins] came from all quarters to destroy his silkworms, and gave him more trouble than all the other birds together."[30] Samuels's intriguing comments raise the question of whether or not the insects he saw in Trouvelot's back yard were gypsy moths. Samuels said they "resembled, when small, the young caterpillar of apple-tree moth."[31] There is no longer a way to determine Samuels's expertise in identifying larvae, but it is perhaps an odd coincidence that in 1865 he mentioned the gypsy moth in a paper he read before the Massachusetts State Board of Agriculture: "During the year 1848 an enormous quantity of the *Bombyx (Ocneria) dispar*, a well known enemy of [German] gardens and forests, had devoured the foliage of the trees, which in some localities were quite bare. In the autumn, millions of their eggs were discovered, enveloped in a silky sort of covering, and attached to the trunks and branches. Many were removed; but the hand of man was powerless to work off the affliction, and the owners of the trees resigned themselves to their loss."[32]

The puzzling question of why Samuels would have spoken to an agricultural organization on the topic of a foreign insect that at the time was not known in North America can be answered once the original text is in hand: Samuels was not talking about insects per se but about the power of birds as natural controls to offset the awesome multiplication of most insect species. It

is an indication of things to come that economic entomologist Archie Howard Kirkland later used this passage to show how dangerous the moths were. Unfortunately, however, to strengthen his case he left out the last sentence: "But on the approach of winter the titmice and wrens paid daily visits to the affected trees, and before spring had arrived the eggs of the insect were entirely destroyed."[33]

By the time of Samuels's visit to Medford the Civil War was over, and with it ended that era's best opportunity for riches in the silk trade. Trouvelot's experiments had gone well enough, but he could not rush nature, and it had taken him until 1865 to gain sufficient experience to contemplate raising silkworms on a commercial scale. His silk moth experiments had been hard work with little reward for Trouvelot, who put in long days overcoming the problems of cultivating *T. polyphemus* and who is generally credited with discovering the best way to unreel its cocoon.

In the course of his work, Trouvelot made himself into a respectable entomologist. He studied assiduously to improve his knowledge, and he once wrote to Samuel Scudder, a prominent Boston entomologist, that during the winter of 1868–69 he had "hardly gone to Boston more than twice, having worked to my favorite studies all winter."[34] He had begun a collection of insects, mostly lepidoptera in the family then named Bombycidae, and his writings for the *American Naturalist* refer several times to his "cabinet" of specimens. He told Scudder that he was acquainted with almost all of the one hundred species of New England butterflies then known to entomologists.[35] Trouvelot understood the population dynamics of moths and butterflies in a way that most other entomologists of his time would not realize for another thirty years. He mentioned that if even one of every hundred larvae survived and reproduced, populations would not decline from year to year and might even increase.

Trouvelot was also aware that Lepidoptera received the world mainly through their antennae, although he had not worked along these lines far enough to discover the phenomenon of pheromones or understand their chemical basis. He noted the important contributions of small mammals in reducing moth populations and the similar suppressing effect of toads and snakes at a time when little was known about them in this respect and almost no other naturalists were working along these lines.

Trouvelot also had an interest in parasites that was remarkable for the times. He observed caterpillar parasites such as the Ichneumon fly and was the first to describe the methods it used to parasitize its host. At this time, little was known about many insects and almost nothing was understood about parasitic insects except that they existed. Until 1868 no one in America except Trouvelot is known to have seen an Ichneumon fly in the act of depositing her

eggs on a caterpillar. Trouvelot had written to Dr. Wilder at Cornell that he had witnessed such events, and that the fly alighted not on the caterpillar's back but along its side.[36] At one point he sent Scudder drawings of an entozoan (parasite) of rabbits with an explanation of its habits, and included drawings of a large dipterous larva he found on the rabbit's neck.[37]

Dividing his time between his canvas and his caterpillars would have allowed Trouvelot to work at home when the insects were in their larval state. During the caterpillar season the silkworm experiment demanded ceaseless attention: the insects required continuous feeding; the breeding platforms had to be swept clean three times a day; the netting required constant repair; and in the time left free, Trouvelot assumed the Sisyphean task of keeping the birds from devouring his insects.

In the fall of 1866, Trouvelot's practical experiments with *T. polyphemus* seem to have reached their peak. At this time he was trying to raise two "broods" annually, or at least to stagger the breeding times under controlled conditions so that the hatch of caterpillars would be spread throughout the spring and summer. Although Trouvelot was satisfied that he had solved the difficult problems of breeding this insect in captivity, the silk it produced, although useful, was considered coarse and inferior to the fine silk of *Bombyx mori.*

About this time, Charles Valentine Riley, in his post as state entomologist of Missouri, was writing on the American silk moths in his *Reports on the Noxious, Beneficial, and Other Insects of the State of Missouri.* Trouvelot and Riley exchanged correspondence on Cecropia and *T. polyphemus* moths, and it seems that Riley, then young and not fully experienced, respected Trouvelot's work. Trouvelot had succeeded with *T. polyphemus* to a point beyond that attained by all other researchers and was accepted as an expert on the species. He had discovered that the emerging moth produced a "dissolvent acid" that allowed it to leave its rigid cocoon without breaking a single fiber. He described it so well that in his annual report Riley quoted Trouvelot's description verbatim.[38]

The Insect Invasion

America was being infiltrated by a host of foreign insects that arrived on purpose or by accident, but because of the disorganized state of entomology, men of science were slow to understand the adverse consequences, and government authorities were ambivalent about regulating the practice. Entrepreneurs did not think twice about bringing a new species of silkworm or a new variety of Italian honeybee into the country, because these insects were considered legitimate items of commerce. There were no legal, moral, or ethical

restraints against the practice of transporting alien insects anywhere. The Japanese oak silk moth (*Antheraea yamamai* [Guerin-Meneville]), called colloquially *tensan* in Japan, was brought to Austria around 1860, and by 1868 the Baron de Bretton was able to reel 16,000 cocoons per year.[39] The Japanese had been raising *tensan* commercially for more than a thousand years because its silk was so prized that it commanded a premium price. Yet for some reason the interest of the Austrians in *tensan* silk waned; the project was abandoned, and the insects were released. The species is still found today in parts of southern Austria in the area once known as Tyrolea and also in northern France, where its defoliation of trees has become a problem.

In 1865, Townend Glover, the first federal entomologist, had an epiphany on this matter while attending the Paris Exhibition. He realized that one day the continued arrivals of new insect pests in North America could prove to be a disaster. In his section of the 1865 *Report of the Commissioner of Agriculture*, he issued a prophetic warning that described the future history of the gypsy moth in North America: "As European insects are at any time liable to be introduced into this country . . . their nature and habits cannot be too well understood here. . . . One pair of new noxious insects will do more harm than hundreds of the well-known varieties, as the progeny might commit their ravages unsuspected till they multiplied past the possibility of extermination."[40]

[CHAPTER 2]

The Gypsy Moth Comes to America

On November 2, 1866, Trouvelot sailed for Europe, where he could obtain the eggs of continental silk moths as well as some recently introduced exotic specimens.[1] It is likely that he stopped in Paris to see Guerin-Meneville, a man who would have been most aware of the latest introductions and their availability. Trouvelot might have had the idea that a few imported varieties would do well in North America or that he could find some that would interbreed with the New World's silk moths. On the basis of his experiences with Cecropia and Polyphemus, he would have insects that could tolerate handling, relocation, and disruptions well, would thrive on a varied or changing diet, and would not be aggressively sought by natural predators—in short, moths with traits that would lend themselves to commercial production practice. He also knew that a replacement silkworm should be highly resistant to disease. In many of these respects, the gypsy moth would have seemed an ideal candidate.

As a practical matter, raising millions of caterpillars in captivity required enormous amounts of vegetation, and for most caterpillars the leaves had to be fresh and of a certain variety or they would refuse to eat. One solution to this problem would be a caterpillar that would eat whatever was locally available. Trouvelot must have looked around him and, seeing almost nothing but oaks, determined to find an insect for which oaks were the preferred species. Some years later, Nathaniel Shaler recalled that a preference for oaks was one of the traits Trouvelot had looked for when selecting silk moths for his experiments.[2]

There were some drawbacks to using the gypsy moth as a silkworm. The cocoon spun by the gypsy caterpillar is a slap-dash affair of thinly crisscrossed strands barely adequate to support the pupa; unreeling it would be not only impossible but pointless; and the silk spun by the larva, being coarse, ragged, and mildly toxic to some, would have had no commercial value at all.

So one can only speculate that the attraction lay entirely in its extraordinary vitality.

Trouvelot was back in Medford by March, when he wrote to Scudder that he had been "absent from home" and was replying to letters he found waiting for him on his return.[3] He could have resumed his experiments with *T. polyphemus*, because he was on the verge of a great success in farming them, but he seemed intent on trying some European and exotic Asian species. Most entomologists and others who have studied this period believe that Trouvelot brought gypsy moth egg masses with him when he came back, although any evidence that he did so has long since vanished.

Trouvelot wrote a lengthy article in three parts about his silkworm project for the then new magazine called the *American Naturalist*. The idea for the magazine came from Frederic W. Putnam, curator of the Essex Institute, and the editors were Alpheus Hyatt, Edward Morse, and Alpheus Packard. The common link of these four young men was that they had all been students of Agassiz at the Museum of Comparative Zoology, and all had varying degrees of acquaintance with Trouvelot as a result of his presence there and in the Boston Society of Natural History. Packard had visited Trouvelot a few years earlier and already knew about what otherwise would have been an obscure experiment taking place in an isolated woodlot behind a nondescript house in Medford. Although the content of the *American Naturalist* was not rigorously professional, Trouvelot's writings, appearing in the magazine's first year of publication, conferred on him a certain importance and strengthened his link with the rise of science in America during the 1860s.

Trouvelot most likely went to France for his specimens, but Warren W. Rawson, chairman of the first Massachusetts gypsy moth commission, said that the eggs themselves came from Germany.[4] So did Muriel L. Guberlet when she wrote about Trevor Kincaid's part in searching for gypsy moth parasites early in the twentieth century.[5] Howard later wrote that other European silk moths held Trouvelot's attention but was unable to specify the types of insects or give the dates they were imported.[6] Trouvelot may have brought back nothing pertaining to sericulture but only placed orders for merchandise to be sent to him later.

In a letter written from Paris to Archie Kirkland in Boston, G. Haushalter, a former neighbor of Trouvelot's on Myrtle Street, mentioned that one of the shipments Trouvelot received from his sources in France had contained an unexpected addition: "Mr. Trouvelot, Jr., told me that the eggs of the insect were sent to Mr. Trouvelot by accident by M. Gerard Mennevel of Paris in 1868, and almost at the same time eggs came from Japan which contained the microbes of the [caterpillar] cholera. The eggs of the gypsy moth developed and the insect escaped, but I don't believe the family of Mr. Trouvelot have a

precise knowledge of how or in what stage of development."[7] Walter C. Wright of Medford also believed that the introduction of the eggs was accidental: "I was acquainted with Prof. Trouvelot, and also well acquainted with Lewis Prang, a warm friend of his; and Lewis Prang's statement to me was that the importation was entirely accidental, that the gypsy moth bunch of eggs came on a package of other eggs . . . and they hatched out and [Trouvelot] discovered them."[8]

In a letter written in 1870 in his small, fine hand, Trouvelot told geologist William Healy Dall in Washington, D.C., that the moth he was trying to import was *Bombyx [Antheraea] yamamai,* a large and beautiful oak-eating Japanese silk moth that was a relatively recent introduction in Europe. Guerin-Meneville had classified this insect as a silk moth, *Bombyx yama-mai*, known as *tensan* in Japan—the same insect that Baron de Bretton in Austria tried to raise five or six years earlier. Even though the European experiment with *B. yama-mai* had failed, Trouvelot still felt that the insect was valuable and the only one whose introduction he would recommend.[9]

Haushalter's letter and Wright's testimony increase the possibility that the gypsy moth eggs arrived accidentally and that Trouvelot began his work thinking he was raising some other exotic species of silk moth. All entomological historians have been somewhat skeptical of this scenario because it sounds self-serving, it was put forth long after the gypsy moths escaped, and that someone as knowledgeable as Guerin-Meneville would not have noticed something wrong with the items he packed for Trouvelot seems unlikely. But this, too, is simply speculation.

Michael Gerardi and James Grimm state that the original number of gypsy moths was very small.[10] Trouvelot himself indicated at one point that his initial stock of *Bombyx dispar* larvae was so meager that it could be netted entirely on a single bush in his back yard. Through the spring of 1868 he continued his experiments with his new exotics, raising them alongside his considerable inventory of *T. polyphemus*. At some point of uncertain date and by unknown means, Trouvelot discovered what his new species actually was, possibly by showing the larvae or egg masses to Hagen, who was the only entomologist in the state who would have recognized them on sight. Trouvelot then made the fateful decision to work further with this fortuitous acquisition to see if anything useful could be done with them.

The gypsy moth was then classified as *Bombyx dispar*, which incorrectly placed it in the same genus as the silkworm *Bombyx mori*, but Trouvelot seems to have accepted this designation without question. The taxonomic confusion contributed in no small way to the mischief that followed. During Trouvelot's lifetime the insect was known variously as *Phalaena dispar*,

Liparis dispar, *Porthetria dispar*, *Psilura dispar*, and *Laria dispar*. Within the years covered by this volume it also would be called *Ocneria dispar*, *Hypogymna dispar,* and the name by which it is known today, *Lymantria dispar*. Scientific books of Trouvelot's time commonly used *Bombyx dispar,* a name that did not die out until nearly the end of the nineteenth century.

The success that had rewarded Trouvelot's experiments with *T. polyphemus* was not repeated in his work with *B. dispar*, and the expertise he had acquired earlier turned out to be of little use to him. At first he tried raising the larvae in his breeding shed and then placing them outside to feed on the net-covered trees behind his house. The period of time he experimented with them was relatively short, and the number of gypsy moth larvae never reached anywhere near the million mark he had claimed for his *T. polyphemus*.

Driven by powerful instincts, the newly hatched gypsy moth larvae seek food high in the leafy canopy, ascending the trunks of trees early in the day and spinning scanty little webs of silk on the undersides of leaves, where they rest during the night. Although Trouvelot took steps to protect his caterpillars and confine them to his yard, he might not have understood how extraordinary the precautions for the gypsy moth needed to be. Each day some small number of insects certainly escaped. Trouvelot was fully aware that the larvae of other moths, such as *T. polyphemus*, all had prodigious appetites: "One who has had no experience in the matter could hardly believe what an amount of food is devoured by these little creatures. . . . What a destruction of leaves this single species of insect could make if only a one-hundredth part of the eggs laid came to maturity!"[11]

Although robins and other birds ate the plump and smooth-skinned *T. polyphemus* in great numbers, far fewer birds preferred hairy caterpillars such as *B. dispar*, and some would eat them only to fend off starvation. Over forty species of birds are now known to prey on the gypsy moth, but only about fourteen have an impact on a gypsy moth population explosion—blackbird, bluejay, catbird, black-capped chickadee, crow, grackle, nuthatch, oriole, chipping sparrow, robin, tanager, vireo, red-winged blackbird, and woodpecker[12]—plus two champion gypsy moth destroyers, the red-billed and black-billed cuckoos. These large, foot-long birds often appear in great number in areas infested with gypsy moths, cicadas, armyworms, and other insects that undergo population outbreaks; they eat spiny, hairy, and poisonous caterpillars. But Trouvelot does not mention the appearance of cuckoos. It seems he had ominously fewer problems with birds while breeding gypsy moths than he had while breeding *T. polyphemus*.

After the Civil War ended and the southern cotton plantations recovered, interest in finding alternative silkworms waned and the silk industries in the

Northeast collapsed. Pasteur had shown that removing adult individuals from the breeding stock whenever microscopic examination revealed they were infected could prevent silkworm disease from spreading. So as Trouvelot's incentives for success became less compelling, he may have concluded that he had done enough work with *Bombyx dispar* to know that the insect held little potential as a silkworm.

The years from 1866 to 1870 seem to have been Trouvelot's last and busiest in entomology. His silk moth experiments reached their peak, and so did his output of writing. He gave a short talk on the intervals of egg hatching and molting of the Phasmidae at the Boston Society of Natural History in November 1866.[13] An illness he suffered in the spring of 1867 delayed the drawings he was finishing for Packard's book on moths, and at the time he was also negotiating to do the drawings for Scudder's book on eastern American butterflies.[14] Two papers he wrote for the Boston Society of Natural History and his work for the *American Naturalist* appeared in 1867, and a third paper unrelated to entomology was published by the Boston society in 1870.

Of the two 1867 papers, one in particular, "On a Method of Stimulating Union between Insects of Different Species," reveals unambiguously that Trouvelot believed he had worked out a system for inducing different species to mate, and that he thought it might be possible to obtain viable hybrids from "closely allied species" as others had already done: "I have in my cabinet a specimen given to me by Mr. Guerin Meneville, which is a hybrid from the ailanthus silk worm (B. cynthia) and the castor oil silk worm (Bombyx arrindia). This hybrid is said to be from the twentieth generation. I have often obtained union between insects of different genera; of course there was too great a separation between these types to obtain impregnated eggs."[15]

The idea was clever and simple: three adult moths of the same species would be required, two males and a female. A fourth moth that was a female of a related species would be placed in a cage with the first female, and when mating time arrived for the first female, both males would be released into the cage. One male would find and mate with the female of his own kind, but the second would unite with the other, apparently unaware that his union was with a female of a different species. Trouvelot told a meeting of the entomology section of the Boston Natural History Society that his experiments had revealed the method, and that it had always worked successfully.[16] From the information available to him and as a result of his own research, Trouvelot must have believed there was a small but real chance of breeding a hybrid that could propagate its type through following generations, and it seems reasonable to conclude that many of the exotic moths he had imported were intended for this type of experiment. For Trouvelot, this work simply

represented the same things he always had always done, though with a different kind of moth.

Then, disaster struck: the gypsy moths got away from him.

The Mysterious Escape

In gathering the facts about the gypsy moth's escape, chroniclers of the past did not fare much better than researchers of the present, and the true story had been lost before the turn of the nineteenth century. Alice Bailey Ward, writing in 1893, said, "A cluster of tiny eggs had been blown out of Mr. Trouvelot's window and, like the dust on the palm of Moses, lifted and whirled, had brought forth a plague."[17] In 1897, Fletcher Osgood, who wrote with the advantage of knowing those who had known Trouvelot, could come up only with the following:

> This menacing forager of the Eastern Hemisphere was brought over twenty-six years ago by a French savant, in considerable numbers, to Medford, a suburb of Boston, Massachusetts. The object is said to have been to cross the creature with the delicate silkworm, and so originate a robust, silk-producing hybrid for America; but the statement has been gravely questioned. The scheme, whatever it was, came to nothing, and the gypsy caterpillars, liberated from their netted enclosure by a gale, spread slowly over Medford.[18]

In statements prepared for the Massachusetts gypsy moth committee in 1893 and 1894, a few of Trouvelot's neighbors from 1869 recalled the sight of him searching for the eggs in his yard and stated that "he was much disturbed on being unable to find them."[19] Stories persisted that an agonized Trouvelot tried to warn certain entomologists and possibly officials in local or state government of what had happened, but the course of events shows that any warnings he gave were not taken seriously. Charles H. Fernald, in his 1889 *Bulletin of the Hatch Experiment Station*, related that two of Trouvelot's contemporaries, both experienced entomologists, knew the particulars of the moth's escape, but Fernald himself neglected to tell the story: "Mr. Samuel Henshaw and Dr. Hagen of Cambridge have both informed me that the entomologist who introduced this insect was Mr. L. Trouvelot. . . . Dr. Hagen told me that he distinctly remembered hearing Mr. Trouvelot tell how they escaped from him after he had imported them."[20]

Hagen told Henshaw that Trouvelot spoke on the subject before the entomological section of the Boston Society of Natural History. Hagen also

claimed to have written a record of the gypsy moth affair for the *Entomologische Zeitung Stetten*, a German-language entomology journal, but he could not remember which volume.[21] Henshaw was unable to locate the document, and it appears that if Hagen did write such a paper, it was never published. Haushalter said that Trouvelot had written "a concise resume of the whole affair for a certain American entomologist whose name escapes me."[22] Charles Riley and Samuel Scudder seem the most likely recipients, since Trouvelot was corresponding with both men around this time, but there is no record of any entomologist claiming to have received Trouvelot's recounting.

Charles Riley, entomologist of Missouri from 1868 to 1877 and author of nine famous reports on the insects of that state, did write in his second report: "Only a year ago the larva of a certain owlet moth (Hypogymna dispar), which is a great pest in Europe both to fruit trees and forest trees, was accidentally introduced by a Massachusetts entomologist into New England, where it is spreading with great rapidity."[23] That report appeared in 1870, and notice of the gypsy moth introduction was published in *American Entomologist* and *Insect Life* the same year.[24] Riley's statement that the moths escaped "only a year ago" fixes the date as 1869, which suggests that the insects got away from Trouvelot almost at once. The moth's release was widely known in a short time in places as distant as Missouri. News of the escape was promptly distributed both locally and regionally; entomologists were aware of the threat it posed; and the spread of the moths had been observed. Outside of the small circle of agricultural entomologists, however, the escape of the gypsy moth attracted almost no attention at all.

Geologist Nathaniel Shaler was aware of the gypsy moth experiment even before the escape took place. He had engaged Trouvelot to draw the maps for the *Kentucky Geological Survey*, a compilation that Shaler, who was born in Kentucky, had created from various surveys of his home state.[25] Trouvelot must have mentioned his attempt to breed gypsy moths, and a nervous Shaler urged Trouvelot to destroy his imports: "About thirty years ago I had in my employment a Frenchman, a remarkable man, who was exceedingly experimental. . . . He had the idea of bringing, and had already brought from Europe, specimens of the gypsy moth, with a view of crossing them with some American moths, in order that he might get a hybrid silkworm that would feed on oak leaves. Learning of it I spoke to him about it and told him of the risk which he was running, the risk of settling a pest with us. . . . I begged him to destroy the creatures, which he told me he would."[26]

Shaler knew not only about the gypsy moths' escape but also about their importation, and in 1895 he related the details to Forbush. In *The Gypsy Moth*, the monograph published in 1896, Forbush mentioned hearing the story from Shaler but omitted it from the book, and Shaler's own recounting

has since disappeared. In 1890 and 1891, commissions appointed by the state of Massachusetts to exterminate the gypsy moth attempted without success to correspond with Trouvelot, who was by then living at Meudon near Paris. Fernald, addressing a meeting of economic entomologists in 1895, said that he also had written to Trouvelot and had not received an answer. The information he finally acquired came secondhand: "I was informed a short time ago that a gentleman was with Mr. Trouvelot in Paris not long before his death, and Mr. Trouvelot told him that he brought the eggs over from France, and when they hatched he put them on a shrub near his house and covered them with a mosquito net, and that a storm came up in the night and tore the net to such an extent that the insects escaped. I suppose that this is the way that the insect escaped, although we have another story."[27]

Entomologist Archie H. Kirkland, writing in 1905, filled in a few details that Fernald left out. He shed no light on what the "other story" might have been but said that the "gentleman" in question was "the late Alvan Clarke, the well-known lens maker of Cambridge."[28] This must have been Alvan Clarke's son, Alvan Graham Clarke, since the elder Clarke had died in August 1887. Trouvelot's story of the gale and the shredded netting conflict with his comments that his nets already had holes in them big enough to admit a robin and the eyewitness accounts of his Medford neighbors who swore they saw him looking for eggs in the grass outside his house. Despite romanticized embellishments of the great getaway, one of which depicts a frantic and exhausted Trouvelot digging in vain through the Medford dump for his discarded egg masses, the truth of the story is likely mundane: Trouvelot had treated the gypsy moths no differently from the others he raised, which allowed the insect to escape. The tiny caterpillars simply crawled away or were wafted by the breezes into areas nearby.

Trouvelot after the Gypsy Moth

Most entomological historians consider that Trouvelot abandoned his insect work at this point, but tracking Trouvelot is like following footprints across a river. For a few years after the gypsy moth escaped, he continued his silkworm research, but then disaster struck again. As he mentioned in his letter to Dall, the shipment from Guerin-Meneville had been infected, and by 1870, disease had swept through his insectary and destroyed most of his caterpillars.[29] In addition, he no longer had enough time to spend attending silkworms because he was occupied with other obligations.[30] Some of these were likely in the field of astronomy, in which Trouvelot, now entering his forties, began to pursue the successes that had eluded him in entomology.

Trouvelot always retained an interest in entomology, though, and confided

to Scudder that he enjoyed drawing insects.[31] He kept up his correspondence with Riley into 1870, and in 1877 he wrote an article on insects' use of antennae for the *American Naturalist*. Samuels, writing for *Scribner's* in 1879, still considered Trouvelot to be America's most knowledgeable silk moth researcher.[32] In 1880, Trouvelot engraved the woodcuts for Packard's bulletin on the Hessian fly, published by the U.S. Entomological Commission.[33] Trouvelot's contribution to Scudder's book on the butterflies of the eastern United States was substantial as well.[34] Although he ceased working for Scudder after 1882, and the butterfly book was not published for another six years, Trouvelot lent or donated captured specimens for study, and Scudder's records credit him with coloring 112 illustrations.[35]

If Trouvelot continued to work with caterpillars after the escape of the gypsy moths, anything on a large scale must have concluded by mid-1872, because at this time he moved with his family from Medford to 99 Garden Street in Cambridge. There he began a productive association with Professor Joseph Winlock, director of the astronomical observatory at Harvard College, and the *Cambridge City Directory* for 1873 gives his occupation as "assistant at the observatory."[36] Winlock engaged Trouvelot to work as an artist in the preparation of a volume of drawings to be published by the observatory, underwritten by a $2,500 grant from the Bache Fund. Trouvelot made the original sketches and the finished drawings for thirty-five lithographic plates, beginning his work on July 11, 1872, when the project started.[37] The book was published to great acclaim in 1875, and Trouvelot's drawings were admired for their "great fidelity and artistic beauty."[38]

The *Annals of the Astronomical Observatory at Harvard College* for 1876 lists "Mr. Trouvelot," as an observer and reports that he was not associated with the observatory after his work as an artist was completed in 1874. In 1875, Trouvelot was at work for Shaler on the maps for the *Kentucky Geological Survey*, published in 1876, and for the *Cambridge City Directory* that year he gave his occupation as "draughtsman."

Trouvelot quickly gained a reputation for his astronomical illustrations. In 1876 he exhibited many of his exquisite pastels in the Art Gallery and the Naval Observatory exhibitions of the Centennial Exposition in Philadelphia. After 1876 he was again associated with the Harvard observatory and in 1878 entranced the public with 24-by-36-inch drawings of sunspots and the Andromeda nebula. Scribner's publishing house listed Trouvelot's *Astronomical Drawings* as one of its most successful books of the period, which is all the more remarkable, since the volume contained just fifteen chromolithographs yet sold for the prohibitive price of $125.[39]

In 1881, Trouvelot, still residing at 99 Garden Street with his son, George,

listed his occupation in the *Cambridge City Directory* as "astronomer." In this year he attained his highest honor when he was elected to the American Academy of Arts and Sciences.[40] He also received an offer from the French government to take a well-paying position assisting solar astronomer Jules Janssen at a new observatory housed in the reconstructed Meudon castle just outside Paris. Opportunities for advancement in scientific fields were few and far between at this time, and when one appeared it was never taken lightly. Trouvelot accepted the offer—though only after difficult consideration—and the *Cambridge City Directory* for 1882 holds the last listing for him in the United States.

Although some evidence suggests that the moth's escape had been completely forgotten by the few people who knew about it, Haushalter cited as one of Trouvelot's reasons for leaving America that reporters seeking information about the gypsy moth were beginning to harry him. In any case, Trouvelot set foot on his native soil again in 1882, the same year that his former neighbors on Myrtle Street first began to notice that their fruit and ornamental trees were being attacked in the spring by a strange, hairy, black caterpillar with crimson and blue dots on its back.

The Gypsy Moth after Trouvelot

For the first few years after the escape, gypsy moth activity in the vicinity of Myrtle Street and the nearby Glenwood Station was too slight to attract attention. The area into which the moth had gone consisted of small trees and dense underbrush. The Medford fire chief often complained about the frequency of blazes in this area and the difficulties of extinguishing them, and it is likely that the recurrent conflagrations helped at first to keep the gypsy moth population down. Still, the moths were spread throughout an area that was extremely favorable to their survival, and although fires were an important factor, perhaps their failure to increase their numbers swiftly was caused by the disease that had come unnoticed on Guerin-Meneville's shipment from Paris.[41]

Trouvelot, normally communicative on the subject of caterpillars when writing for magazines or rubbing shoulders with well-known naturalists and entomologists, fell silent when it came to exchanging a few words with his neighbors about the portent of recent events. Only he could have identified gypsy moth larvae on sight, and Forbush states that Trouvelot is known to have seen them in the woods near his house during the years immediately following their escape.[42] As far as can be discovered, though, Trouvelot remained mute about his observations, attempting no further warnings to his

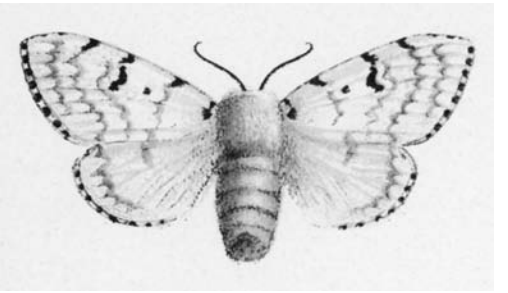
neighbors except for one instance noted by Haushalter: "I personally remember him destroying egg clusters and asking myself and companion to do likewise and telling us at the same time of the development from the eggs to the full grown insect. . . . Mr. Trouvelot . . . was worried greatly by reporters and having informed very fully some American gentlemen, he decided to say nothing more."[43]

At the time, only Trouvelot might have spoken with enough authority to spur his neighbors to action. Yet when the residents of Myrtle Street and surrounding neighborhoods made statements to the gypsy moth committee two decades later, they could not understand how the presence of such a voracious insect had escaped notice for twenty years and were uniform in their recollection that neither they nor anyone else knew what the caterpillars were. Riley and Howard were also puzzled about the insect's invisibility: "It is, indeed, a curious fact that during these twenty years the insect has not become a pest, and still more curious that the moth does not seem to have found its way into the collections and is not mentioned in the check-lists."[44]

Trouvelot: Pioneer Researcher or Entrepreneur?

In the last analysis, was Trouvelot a scientist or a businessman? In an era when the distinction between scientific and commercial endeavor was beginning to narrow, it might not be unfair to say that he was both and neither. He had concerned himself with broad areas of experimentation during his years of fascination with insects: the breeding of better silkworms, the mechanics of raising them, and the process of transforming their raw silk into a commercially useful form. Trouvelot's attempts to secure them were more entrepreneurial in concept than scientific; the nets he placed were intended not to protect the North American forests from the gypsy moth but to protect the gypsy moth from the birds. Trouvelot was also a prospector of sorts. He had wrapped his enterprise in a scientific mantle, yet he was not only studying but mining the insects of North America. His underlying hope was to get rich, and he referred to his silkworm farm not as a scientific or field laboratory but as his "infant industry."[45]

As a part-time scientific researcher, Trouvelot's few experiments seem rather shallow and insubstantial, and his reports reveal more about his powers of observation than about his scientific acumen. Nevertheless, his method of work and his perspective on research were much different from those of other entomologists of his day. His areas of interest—parasites; the function of antennae in moths and butterflies; the effects of mammals, birds, and reptiles on insect populations—would have made him a worker far ahead of his time had he concentrated on entomology.



Female gypsy moth.
From *The Gypsy Moth.*

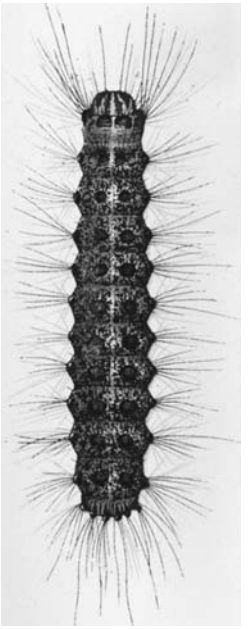
Male gypsy moth.
From *The Gypsy Moth.*

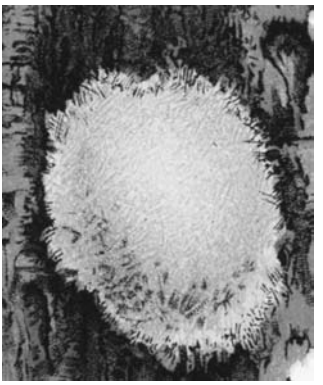
One might expect that a scientific researcher who worked for ten years on a project of great magnitude would have published his findings in a scientific journal and used his skill as an illustrator to record the insect in detail, as was the practice of all naturalists of the day. Yet as Trouvelot mentioned to Dall, the popular articles that appeared in the *American Naturalist* were the only things he ever wrote about his silkworm experiments.[46] Trouvelot drew professionally and had little time to draw for pleasure. As he told Scudder, "I have not in my possession over a dozen drawings of larvae and pupae of New England butterflies."[47]

Trouvelot's idea of crossbreeding insects must be regarded with some amazement. Although interbreeding individuals of the same species for the selection of desirable traits had been practiced for generations in everything from livestock to silkworms, the kind of hybridization that Trouvelot considered was an unknown art in the scientific world of the mid-nineteenth century. He had devised a clever way to trick dissimilar moth species into mating, but the hope of creating a fertile hybrid was too far ahead of its day. Gregor Mendel's seminal work with peas in Europe was proceeding in obscurity at this time, and the famous fruit fly experiments in the United States, which were the first attempts to understand genetic manipulation of insects, were still fifty years in the future.

The most that can be deduced about Trouvelot's scientific or entrepreneurial goals was that he cast his net as widely as he could and tried a number of different schemes without having had previous experience in any of them. Like many others of his time in similar circumstances, if success had come in great measure with one of his projects, he likely would have abandoned the others—as he seems to have dropped his work with insects when his astronomical drawings brought him recognition and prestige.

Reviewing his decade of effort with silk moths, which must have been on





Gypsy moth egg mass.
From *The Gypsy Moth.*

Female gypsy moth larva.
From *The Gypsy Moth.*

his mind when he wrote to Dall, Trouvelot reflected on the ephemeral promise of this kind of work with substitute insects such as Cynthia and Ailanthus: "I have seen this worm and know its products. I am decidedly adverse to its introduction as I know positively that the culturist could not realize in the end of the season the money he would have spent for buying the eggs. . . . All of us are inclined to look too often through the colored glasses which are the same color as our favorite ideas."[48]

[CHAPTER 3]

The Caterpillars Are Coming!

EACH SPRING DURING THE 1880S, hundreds of caterpillars crawled over the shed behind William Taylor's rented house at 27 Myrtle Street. Taylor knew that the former occupant, Leopold Trouvelot, had experimented with sericulture but was unaware that the insects he saw were not silkworms. Taylor had no use for the annoying caterpillars and sold the shed to W. B. Harmon on nearby Spring Street. It was this act, Taylor later told the gypsy moth commission, that caused the appearance of the insect in another location and explained how its numbers came to be so great.[1]

The Harmon house was located at the end of a sparsely built-up street and adjoined a wooded lot even larger than the one behind Trouvelot's old house, but the gypsy moth activities there at first attracted no attention. The vague warnings published by Riley had been met with indifference, and interest within the entomological community had been brief. In short, as Trouvelot's little blunder was soon forgotten, the gypsy moth became widely though thinly dispersed. Its greatest concentrations occurred along transportation routes, as these offered the best means for distribution: egg masses or larvae were transported on wagons, either attached to some inconspicuous spot or as part of the load. Egg masses were later found in piles of bricks on their way to job sites or on the bark of firewood distributed to homes throughout the city.

Trouble began occurring as early as 1882. Mr. and Mrs. J. W. Flinn, who lived near Trouvelot's house until 1886, noted that the insect was becoming destructive, defoliating apple and pear and maple trees in their yard, eating the peas and beans and corn in their garden, and entering their house, where the couple "would even find them upon the clothes hanging in the closets."[2] The moths overspread the wooded areas south of Myrtle Street and crossed the railroad tracks, but did not advance very much to the north. William Taylor's problems with caterpillars had not ceased with the sale of Trouvelot's shed, and his experiences gave warning that there was something nasty about these little creatures: "I fought the caterpillars of the gypsy moth for ten years

before the State did anything. In their season I used to gather them literally by the quart before going to work. It is a fact that I have been made so sick while doing this that I vomited up my breakfast."[3]

By 1883, reports of defoliation in Medford were increasing but were still paid little attention. Mary and William Belcher of 29 Myrtle Street had been bothered by caterpillars for six or eight years, but Mary Belcher later told the gypsy moth commission that the problems they caused were so slight that nobody bothered to ask what the caterpillars were. This situation soon changed. By the spring of 1886, trees on the Fenton estate at 10 Myrtle Street were so full of caterpillars that shaking the branches brought a shower of larvae down on one's head. Thomas and Lina Mayo of 25 Myrtle Street awoke one morning in the spring of 1887 and were startled to see what appeared to be the results of a fire in the verdant woods behind their house. The puzzled couple investigated and discovered that the charred appearance was caused by thousands of black gypsy moth caterpillars clustered under the branches.

By 1888, moth populations in Medford had risen, and pronounced defoliation was occurring in the neighborhood. D. W. Daly of 5 Myrtle Street watched as his fruit trees were stripped bare. In the mornings he spent an hour sweeping dustpans full of larvae off the side of his house. Lina Mayo's fruit trees had been defoliated for several years in a row, and nine had died as a result.[4] She had spent most of her time during the summers of 1887 and 1888 trying to rid her premises of the larvae: "The caterpillars [covered] the basement and clapboards of the house as high as the window sill. They lay in a solid black mass. I would scrape them off into an old dish pan holding about ten quarts. When it was two-thirds full I poured kerosene over the mass of worms and set them on fire. I used to do this a number of times a day. It was sickening work. I have used, in burning caterpillars, five gallons of kerosene in three days."[5]

The Swarms of Medford

The mild winter of 1888–89 produced so little snow that the mortality of the gypsy moths' overwintering eggs was negligible. Unimpeded by natural restraints and presented with abundant sources of food, moth populations exploded. Similar outbreaks were reported two miles away at West Medford and at Edgeworth, about a mile to the east. In Glenwood the depleted food source triggered a mass migration of larvae across Myrtle Street, turning its surface black with the bodies of fast-moving caterpillars.

Citizens could only stare in disbelief as the dirt streets became carpeted with millions of larvae that seemed to have materialized out of the earth. People cried out, "The caterpillars are coming!" as a vast, black, living wave

of insect life undulated and writhed down the street. Witnesses recalled that it was impossible to count the caterpillars because of their great numbers and fast movement. The insect armies moved from one source of food to another, and none of the hastily mounted defenses could stop them. Great, pulsating masses of larvae stripped any plant along their path in minutes. Many residents later mentioned how the caterpillars moved from "yard to yard, house to house, and street to street" with almost supernatural precision.[6] J. S. Cotton of Medford said they were "the most ravenous worms I ever saw. They would eat almost everything."[7] Mary Belcher spent hours sweeping caterpillars into a pan or scalding them with boiling water, after which she dug a hole and buried them "so as to prevent a stench."[8]

The streets of older cities such as Medford and Malden were lined with majestic elm trees, and after defoliating all the fruit trees, the caterpillars thronged toward these towering giants from all sides as if drawn by a beacon. One resident said their black bodies looked like a living carpet unrolled across the ground and up the trees. The larvae ascended the trunks in massive swarms, turning them black with caterpillar life, and defoliated the elms within two days. Residents walked down the middle of the streets to avoid the thousands of caterpillars spinning down from the trees. The larvae so thickly covered the sidewalks that one could not walk anywhere without crushing them. The ruptured caterpillars exuded slimy ooze that made footing uncertain; people hurrying home often slipped and fell into the gore. Myrtle Street was so bad that people detoured around it rather than face the swarms. Kerosene became in short supply, as many residents used ten or fifteen gallons each week to fuel caterpillar crematoriums in ditches, pails, and storm drains.

The oaks surrounding McGowan's tannery were swiftly denuded. F. T. Spinney's wife grabbed a torch and burned the caterpillars off tree trunks in her yard on Cross Street, while her husband scalded the larvae on their fence with boiling water. J. C. Miller of Lauriat Place had some printer's ink and banded his fruit trees with it, which saved them. He had to work fast because the caterpillars occupied themselves in the Spinney's yard only a few hours before swarming again. Miller said he destroyed thousands with rags soaked in kerosene.[9] Crushing and burning the caterpillars, and the smoke and stench of their funeral pyres, made some people sick. Others proved sensitive to the irritating hairs of the larvae; the caterpillars that fell on William Belcher's unprotected neck and wriggled under his collar caused a painful rash and raised blisters on his skin.

Not knowing what else to do with the mounds of dead caterpillars, some people swept heaps into the gutters and left them there; some incinerated them; others buried the insects in backyard pits. A few fed the living insects to their hens. Still more attempted to save their trees by tarring them or wrapping

their trunks with sticky bands of cloth, but the caterpillars came in such unthinkable numbers that they bridged these barriers before the bands could be changed. One resident said so many were vying for space that they jostled each other off the trees in bunches; another commented that the insects were so tightly packed there was not enough space between them to place a pin. D. M. Richardson reported that the caterpillar columns left a visibly trampled path in the dirt behind them where they crossed the road.[10] One resident watched in amazement as a surging wave of starving larvae passed through her strawberry beds without eating a leaf; another stared in terrified fascination as all arboreal foliage disappeared before her eyes. Oddly, the pear trees on Myrtle Street remained almost untouched, although the pears on other streets were stripped almost completely. Curiosity seekers were drawn to see the effects of the defoliating insects for themselves, and many returned home with unnoticed living mementos of their visit.

Commuters, rushing to catch their trains wore coats and hats in the mild spring weather as they ran through the maze of suspended larvae, arrived at their destinations covered with caterpillars. Sylvester Lacy of 9 Daisy Street dreaded going to the railroad station, which he likened to running a gauntlet.[11] Many gypsies rode the train to Boston concealed in the cuff of a gentleman's trousers, nestled in the pocket of an overcoat, hidden behind an upturned collar, or perched on the brim of a lady's hat. Caterpillars swarmed across the rails, which were stained green by their crushed bodies after the train had passed.

Life began to revolve around the caterpillar swarms as people sought ways avoid them, but there was no escape. Mrs. I. W. Hamlin, who lived at the corner of Spring and Myrtle Streets, wrote: "Time and time again I have stayed out in the yard for two hours at a time catching caterpillars. But in half an hour afterwards they seemed to be just as thick again. It was a common remark in our house, 'Well, it is time to go out and make our rounds again,' and then we would sally out with our pans."[12]

Homes did not provide a refuge. Doors could hardly be used, and the caterpillars poured through basement vents and screenless windows; large numbers came into houses by crawling down the chimneys. The hungry insects foraged through the dwellings, eating potted plants and any vegetable matter they could find in the kitchen. People retiring for the evening would find caterpillars beneath their pillows and turn down their blankets to find caterpillars between their sheets. The sound of millions of caterpillars chewing was clearly audible. Even the noise of the caterpillar droppings was loud enough to keep many awake, and a disgusting stench hung heavily over the town. J. O. Goodwin of Hall Park, Medford, wrote that the swarms made the ground look like a Persian rug, and the black insect masses covered houses up

to the eaves. Goodwin hated the caterpillars and fought them relentlessly: "When they speak of a hundred tons [of larvae] being destroyed, I am quite sure that I have destroyed more than two tons myself."[13]

Selectman W. C. Craig of Medford was riding home on the afternoon train from Boston one day when he saw a small orchard that was barren of leaves. He remarked to the lady next to him that he was not aware of a fire occurring in this particular orchard. The woman replied that there had been no fire but that the armyworm had stripped the trees. Most people believed the insects were armyworms, since the *Boston Herald* had reported a serious outbreak of that insect in nearby Maine toward the end of May.[14] Craig went to the town building in Medford and, in the company of several others, set out to investigate. They found, as he later recalled, an insect that no one had ever seen before.[15]

Craig did not have to look long for more caterpillars; in the days that followed, the caterpillars found him. Swarms of them nearly engulfed his house on Woburn Street, and he and his family exhausted many long afternoons scraping the messy creatures from their trees with wooden shingles. Craig could not walk out his front door and reach the sidewalk without crushing hundreds of them into a slimy green mass. When the worms were not in his shade trees, they were in his fruit trees; when they were not in his fruit trees, they were in his flowers and gardens. He would not have any spinach, dandelions, or tomatoes that year. Whatever kind of worm had visited Medford seemed to eat just about anything. W. B. Harmon's orchard on Spring Street was completely defoliated. Stupendous numbers of caterpillars had swarmed toward Crockford's greenhouses. Encountering 27,000 carnation pinks, they ate them down to the ground and, once inside the glass structures, denuded every single rosebush there.[16]

Craig made an inspection with a friend, the civil engineer and surveyor J. O. Goodwin. At the end, he was sure these caterpillars were not armyworms, and he decided to inform his colleagues on the board of selectmen. Craig also met with influential citizens and state officials to warn them of the danger of leaving the insects unchallenged. Former Senator Boynton, the former Medford mayor, General Samuel Crocker Lawrence, and Representative J. Henry Norcross, among others, personally guaranteed funds to fight the insect through the Medford road commission until a town meeting could be called.[17] Craig recounted: "I conferred with other members of the board, but we had nothing to do with the trees on the streets or in the orchards of town. Mr. Goodwin and myself waited on the road commissioners and asked them to spend some money stopping the ravages."[18]

The road commission met on July 1, 1889 but the commissioners did not have any idea what to do about the problem. Earlier that year, many trees in

Medford had been wrapped with fabric bands soaked in sticky printer's ink to protect them from the canker worm, and the commissioners, believing that technique might be effective against the new caterpillars as well, decided to refresh the ink, a task that was begun the next morning. Early the next evening the low angle of the setting sun cast the shadows of coming events over the citizens of Medford: when the fabric bands were lifted, thousands of fat, hairy, black caterpillars were discovered hiding beneath them.[19] At a July 15 Medford town meeting, $300 was voted to the roads commission for protecting the trees from the caterpillars, augmenting an earlier appropriation of $500 for the usual care of shade trees.

John Stetson, who lived about a mile west of the old Trouvelot house and saw that the defoliation of his trees and shrubs was unusually severe, later said, "I discovered [the caterpillars] in 1888 on a quince bush. I noticed one day that the leaves were all off from this bush. I examined it, and found there were worms clustered on the limbs."[20] When the same kind of defoliation happened the following year, he took some larvae to Boston and showed them to William Sessions, secretary of the Massachusetts State Board of Agriculture.

William Robert Sessions (1835–1914) was a tough and pugnacious self-schooled farm boy who had survived a crippling accident as a youth. He had held the offices of moderator and selectman in the Town of Wilbraham and later the Town of Hampden. He had served in the Massachusetts legislature, both house and senate, where he gained a great deal of experience in the brawling, bare-knuckled style of politics practiced in the public arena of his day. In 1887 he was appointed state agriculture secretary.[21]

While pondering what to do with Stetson's samples, Sessions made a crucial decision that irreversibly altered the course of subsequent events. He could have availed himself of the expertise concentrated in Boston, where an inquiry to the Natural History Society might have secured the services of an entomologist such as Samuel Henshaw or Samuel Hubbard Scudder, the latter considered the greatest American expert on moths and butterflies. Or Sessions could have tapped into the unparalleled resources at Harvard College, which was then America's premier institution for entomological instruction, thanks to the presence of Hermann August Hagen, a man whose opinion was so highly regarded that Leland Howard called it "the last word" in entomology.[22] Instead, Sessions told Stetson to send his specimens halfway across the state to be examined by a self-trained entomologist, Charles Henry Fernald, a professor of zoology at the Massachusetts Agricultural College in Amherst, of which Sessions was a trustee ex officio. That Sessions preferred to take the matter to Fernald was likely due to his belief that the services of an agricultural entomologist would be more advantageous than those of any other kind of entomologist; without a doubt he viewed the problem as an agricultural one. With

this decision, the die was cast; the new insect henceforth would be viewed as an agricultural pest, and the agricultural philosophy in approaching the problem would attain a tenacious stranglehold for the next ten years.

Charles Henry Fernald

Charles Henry Fernald was born on March 16, 1838, at Mount Desert Island off the Maine coast in the house that his great-grandfather had built and in which three subsequent generations of Fernald men had been born.[23] He came into the world at a time when formal educational opportunities were scarce. As a young boy he tutored himself in the many natural subjects that interested him. At the age of fifteen he went to sea during the summer and was both a student and a teacher in the local public school during the winter. He taught himself to draw because he remembered things better once he had illustrated them.

He studied music with Maria Elizabeth Smith, whom he married in 1862. The new Mrs. Fernald also developed into a capable entomologist and collector, becoming one of just a handful of women who were making their way in a field that would remain almost exclusively male for nearly a century more.[24] According to Arnold Mallis, the couple began studying entomology at the same time, and Maria eventually became an expert in many of the same insects that interested her husband, including the Tortricidae, Coccidae, and the Tinead moths.[25] Charles once said that his wife could reach out a window, take a moth on the wing, and deposit it in a cage without disturbing so much as a single scale.[26]

When the Civil War broke out, Fernald was enrolled in the Maine Wesleyan Seminary and Female School, then the largest college preparatory school in the state. He volunteered for the navy, and during his shipboard years he studied to enter Bowdoin College, from which he subsequently received his bachelor's degree and an honorary master of arts degree. After teaching at Houlton Academy, he became the chairman of natural history at Maine State College (now the University of Maine) in 1871, and over the next fifteen years he taught botany, physical geography, human anatomy, human physiology, comparative anatomy, and veterinary science.[27] Fernald's areas of expertise included entomology, botany, geology, mineralogy, and zoology—all of which he taught himself—in addition to algebra and trigonometry. He claimed no linguistic skill but mentioned in a letter that he had a working knowledge of French and German. Howard said no entomologist in America knew more about moths,[28] Charles Adams Peters marveled that one man could know so much about so many things.[29] And Mallis referred to Fernald as a "one-man university."[30]

In 1886, Fernald accepted an appointment as professor of zoology at the Massachusetts Agricultural College in Amherst, a land-grant institution that later became the University of Massachusetts. Before he departed from Maine, the state college there awarded him an honorary Ph.D., although he always preferred the title of "professor." At Amherst, Fernald was also placed in charge of entomological research at the Massachusetts Agricultural Experiment Station, founded in 1882 and later renamed the Hatch Station, a position in which he initially served without pay. He soon revived a course in entomology that had languished for ten years after the death of H. J. Clark, and one that had lost almost its entire collection of insects to fire in 1884.[31] He was appointed as entomologist of the station in 1887.[32] The same year he wrote a paper on beetles and, a year later, another on the Orthoptera of New England, publications that initiated a flow of entomological writings from the college.[33]

Charles Adams Peters, later a professor of chemistry at the agricultural college, had been enrolled in Fernald's courses as a young scholar and recalled him as a kindly and soft-spoken man whose students sometimes referred to him as a "fussy old fool" but who was fondly remembered by many who had received their education under his tutelage.[34] If one substituted a cap, turtleneck sweater, and a peacoat for the dress jacket and bow tie shown in the photo, Fernald could be taken for the sea captain he once wanted to be. Fernald described himself as short and stout and, at 185 pounds, too heavy for his height. He is remembered as a genial and affable man, but he possessed a sarcastic streak, and Peters said that when things were not going well, Fernald could become very difficult to deal with. He led a quiet and self-restricted life, immersed in his work; he did not like or attend athletic games at the college, did not smoke, and used alcohol, he said, only to preserve his specimens.[35]

On May 27, 1889, when Stetson's samples were sent to the experiment station, Fernald had departed for a summer of study in Europe a few days earlier. Maria Fernald had taken over entomological work at the station, and her adult son, entomologist Henry Torsey Fernald, was living in Amherst at the time.[36] The caterpillars puzzled the Fernalds, and by a process of elimination they concluded that the larvae might not be a native species. Maria and Henry pored over the station's library, but most books of the day illustrated insects only in their adult form. On June 1, Maria Fernald wrote to Stetson: "Your letter and the box of larvae were received this morning, and I am very sorry that I am not able to give you the information you desire. [The caterpillars] are new to me and also to the station. . . . I think it cannot be an insect which has been abundant enough in past years to cause much damage or it would have been known by some of us."[37]

Charles Henry Fernald in middle age.
Photo courtesy of Special Collections and Archives, W.E.B. Du Bois Library, University of Massachusetts Amherst.

The Fernalds decided to raise the insects until the larvae transformed, and they set up a small insectary in an old barn near the experiment station. The first fact that mother and son noticed about these caterpillars was an ominous one: unlike the caterpillars of other species that died when raised in captivity, these particular insects fed voraciously and thrived. As Henry Fernald recalled later: "The rearing was successful, and when the moths emerged it was evident that they were unlike anything known in this country, so a search through European books available was in order. Finally, in Wood's 'Index Entomologicus' illustrations of them were found and the insect was recognized as the gypsy moth, a well known and serious pest in Europe."[38]

The discovery of the gypsy moth was made known to the local press in Massachusetts, and others as far south as Washington, D.C., learned of the invasion in the July 13, 1889, issue of the *New England Farmer*.[39] Mrs. N. W. C. Holt of Winchester, Massachusetts, sent some living samples on mulberry and apple branches to Charles Riley, then serving as chief federal entomologist in Washington, and Riley said there could be no doubt what the insects were if Mrs. Fernald had identified them.[40] Word was sent to Professor Fernald by mail, and the letter reached him in London.[41] He had been in Berlin just the summer before where he had observed the conclusion of a large gypsy moth outbreak.[42] As he continued his travels during the summer, the professor consulted with colleagues in England, France, Austria, and Germany about the gypsy moth.[43] Kirby at the British Museum warned him: "You should

spend any amount of money to exterminate [the gypsy moth] because it will spread over your entire country. [Yours] is a country admirably favorable to the spread of this insect and it will do a great deal of damage."[44]

Back in Medford, once the last of the large caterpillars pupated, surely a palpable sense of relief swept over the beleaguered citizens. The trees were devoid of foliage, and there was hardly anything green to be found anywhere except the leaves of strawberries and the tops of some onion plants. Mrs. S. J. Follansbee of 35 Myrtle Street said that the cocoons stuck to the sides of the trees as thickly as the egg masses had, and in some places "hung from the trees in bunches as big as a pint dipper."[45] The eaves and gutters of houses were stained black where the caterpillars had clustered, and pieces of steps, railings, and piazzas that had been torn up in the search for them lay scattered about. Picket fences were destroyed or devoid of paint, and there were scorched areas in many yards marking the caterpillars' crematories. On almost every street a number of trees had been cut down to deprive the insects of food and nesting places, leaving fresh, oozing stumps in many front yards.

Next, residents throughout the infested region saw gypsy moths fluttering in uncountable thousands, and soon some trees bore so many egg clusters that their trunks looked as if they had been wrapped in coarse yellow felt. Pearl Martin, a Medford road commissioner, employed some men to scrape egg masses from the trees and burn them in kerosene. Once the workers became practiced at spotting these clusters, they were astonished by the great numbers of spongy masses apparent everywhere. After just a couple of days it became obvious to all that the problem was too great to confront with a small group.

Organizing Entomologists

While the stunned and bewildered townsmen of Medford, Malden, and surrounding Massachusetts communities were catching their breaths, at the end of August leading entomologists were gathering in Toronto for the forty-second annual meeting of the American Association for the Advancement of Science (AAAS). Riley believed that those working in agricultural entomology should create their own specialized organization and that the AAAS meeting would be the place to split off from the society's entomological club and form the American Association of Official Economic Entomologists, later shortened to Association of Economic Entomologists.[46] The small group elected the absent Riley as president, Stephen A. Forbes as vice president, and John B. Smith as secretary. Membership was limited to those who were working in the field of agricultural entomology, with expedient exceptions made for serious college students and others deemed worthy. The new association was quite small

and so eager for applicants that it nearly included among its charter members one E. P. Thompson, a mathematician who had fallen in with the group by accident.[47]

In economic entomology it was thought more important to learn the best points to attack a single pest insect than it was to describe a hundred innocuous new species. The economic entomologist believed that arthropods were either pests and therefore of economic importance or not pests and thus economically unimportant. Most already believed, as did Fernald, that in the entire insect kingdom with its uncounted thousands of species probably no more than five were directly beneficial to man: the honeybee (*Apis*), the silkworm (*Bombyx mori*), the cochineal insect from which red dye was made (*Dactylopius coccus*), the insect from which shellac was made (*Lacifer lacca*), and the lady beetle (*Vedalia [Rodolia] cardinalis*), which consumed harmful scale insects.[48] Even spiders, mantids, and other insect-eaters were not important if the insects they ate were of no interest economically, and innocuous insects were simply ignored.

By adopting such a rigidly circumscribed field of endeavor, the economic entomologists decisively distanced themselves from other groups of entomologists. Amateurs were regarded as "enthusiasts," a derogatory term of the time, who would not be able to understand the work of economic entomology. Systematists and collectors were faulted for concerning themselves only with adult insects that were generally less harmful than the larvae, which caused most agricultural damage. Taxonomists were viewed with some aversion for their practice of fine-splitting insect genera to the point where one variety could hardly be told from another and then claiming credit for their "discoveries" of new species. Economic entomologists found this proclivity so annoying that at their first annual meeting they voted unanimously to approve a resolution by Albert Cook, based on a strongly worded letter from Fernald, that "bulletins of the experiment stations and agricultural colleges should not contain descriptions of new species."[49]

The curious coincidences in the natural world that exacerbated the impact of the gypsy moth in its new North American home were not the only chance influences to affect events in Massachusetts. Just two years before, in 1887, the U.S. Congress had passed the Hatch Act, which created the agricultural experiment station system in all states in the spring of 1888. Until that time few states had experiment stations, and there were only three state entomologists. The Hatch Act greatly increased the need for entomologists to fill positions that were opening in agricultural colleges, experiment stations, geological surveys, and the many natural history museums that were springing up, particularly in the East.[50] But the initial effects of the act proved contrary to

intentions: the lack of entomologists was so acute sometimes that, as Leland Howard said, "it became necessary for men to undertake the work who had no training in entomology at all."[51]

The restricted focus of their work notwithstanding, economic entomologists thought of themselves as thoroughly modern scientists whose views were actually broader than those of their contemporaries. Economic entomologists were among the first in America to accept Charles Darwin's theories of evolution and the contemporaneous thoughts of T. H. Huxley and Herbert Spencer. Riley said that persons in his profession were generally not wedded to theological assumptions and that he himself kept all of Darwin's works "at my elbows."[52] Economic entomologists entered the gypsy moth years influenced to greater or lesser extent by such ideas as survival of the fittest, natural selection, and the balance of nature, although it became clear that they did not completely comprehend the ramifications of these ideas.

Within a few years the life-history studies of economic entomology would go well beyond anything that had been done before and would require practitioners of the discipline to understand the insect and its relationship to nature in its entirety. This prompted Stephen Forbes to declare that economic entomology was "a special division of ecology" and that economic entomologists were in the vanguard of scientists developing a field that would succeed the older study of natural history.[53] (In modern times, when the terms "ecologist" and "environmentalist" are used almost interchangeably, the image of these entomologists literally and figuratively entering their field of work to restore the balance of nature with kegs of arsenic seems incomprehensible.)

The theory of Thomas Malthus (1766–1834) that man's expanding population would outstrip his ability to grow crops was still given great emphasis, and the feared competition between man and insects for food raised the specter of famine. The trend in agriculture was toward monoculture—growing a single crop on the largest possible field. Almost all entomologists of the time understood that insect problems were greatly exacerbated by this practice and that planting a wide variety of crops on smaller farms would largely prevent the danger. Unfortunately, decisions in agriculture were being made not on scientific considerations but on economic ones.

Malthus was barely in his grave when the mechanization of farm equipment resulted in an oversupply of food, and many of the mouths to be fed in America's burgeoning cities were those of people no longer needed to work on the farm. Wheat prices fell so low that many growers were compelled to raise other crops. In Georgia, cotton grown at a cost of seven cents per bushel sold for only five cents per bushel. Farmers in Kansas could not get ten cents a bushel for corn and burned their crops for heat during the winter rather than sell at a loss.[54]

Economic entomologists, however, remained convinced that crop losses inflicted annually by insects would continue to rise and that these losses were an unacceptable waste even in times of abundance. They began preparing for the conflict they were sure was coming. The Hatch Act, which had brought about a sweeping change in the relationship of agriculture and entomology, also gave entomologists a cohesive center of operations in which the substance of their work was largely economic.[55] They had donned the uniform of crop protector and adopted the appealing stance of science in service to agriculture.[56] The labors of earlier naturalist-entomologists such as Thomas Say, John E. LeConte, Thaddeus W. Harris, William D. Peck, and Asa Fitch had taken the avocational and recreational nature of insect study and turned it into a science. Now Riley and his small camp would take the science of entomology and turn it into a profession.

The Consequences of Medford

Fernald returned from Europe in early September 1889 and went immediately to Medford, where he spent an entire day inspecting the infested territory. He could not spare enough time to visit the regions outside of Medford, but he saw convincing proof that the outbreak could not be confined to just one town.[57] The situation left him deeply concerned: "There was a region of perhaps a square mile in which the trees, trunks and branches, were literally covered with clusters of eggs, so that they were yellow. After what I had been told by the entomologists in Europe, I felt quite alarmed about the matter. I thought we had an invasion that demanded careful attention."[58]

Fernald conferred with Sessions, and the two rushed to make another inspection of Medford. A sense of foreboding came over both men when they observed gypsy moth egg masses beyond counting everywhere they looked. They urged Chairman Wadleigh of the Medford selectmen to petition the state legislature to order extermination of the insect by the Board of Agriculture. Wadleigh asked Fernald how extermination should be carried out, and Fernald replied that the foliage should be sprayed with Paris green, a common arsenical insecticide. The selectmen approved a petition at their meeting of October 25, but the legislature was not scheduled to convene again until early January.

The crucial point of the petition was Fernald's recommendation that the insect be *exterminated* rather than suppressed or controlled. Between his first inspection of Medford in September and the middle of November, he researched the European gypsy moth in his library and by correspondence with European colleagues. He knew the problem was not the moths but the larvae, or "worms" as some called them, which fed on any of several hundred

different kinds of foliage. Their preference for oak presented Fernald with a grave scenario, since the forests of Massachusetts had become dominated by various species of oak. The insects were also said to devour orchard fruits and field crops, another unsettling characteristic, because agriculture in eastern Massachusetts was moving toward orchards of increasing size and decreasing variety, and the principal agricultural activity in the Boston region was market gardening, in which acreage was farmed intensively.

By this time the name of Leopold Trouvelot as an entrepreneur and researcher in the natural sciences had slipped into obscurity, and his part in the importation and escape of the gypsy moth had been all but forgotten. Fernald knew the man who had liberated the gypsy moth only as "the entomologist" and had no other knowledge of the moth's American history. He wrote letters to Samuel Scudder, Samuel Henshaw, and Herman A. Hagen for assistance and asked if the insects had increased in number since their escape.[59] Henshaw responded: "I have your favor of the 12th and it happened that I saw Dr. Hagen the same day that I received it and he wished me to include his answer to your letter with mine. The entomologist referred to is Mr. L. Trouvelot and the locality was West Medford. That is all I can give you as positive."[60]

Fernald was surprised that an insect of such conspicuous habits had been on the loose for twenty years and apparently remained invisible the entire time. He told Henshaw that he "could not find a word on it from anyone."[61] He had gathered sufficient information by November, however, to compose an illustrated bulletin titled "A Dangerous Insect Pest in Medford" in which he advocated the use of Paris green to kill the insect. He suggested spraying the poison at the rate of one pound to 150 gallons of water soon after eggs hatched in the spring and predicted that within two or three years the moth would be completely destroyed. Riley, crediting Fernald with the choice of extermination and the use of Paris green, made a premature prediction of success: "If Professor Fernald's recommendations are carried out at all strictly we have little fear of the spread of this pest, and agree with him that it can be entirely killed out with the expenditure of a little time and money."[62]

Riley's optimism was echoed by others in the state, including the editors of *Garden and Forest* magazine. They wrote that it would not be a difficult matter to exterminate the gypsy moth if Fernald's directions were followed and that a successful conclusion would benefit the state by resulting in general legislation to exterminate all pest insects in the Commonwealth.[63]

A letter of opposition, unsigned but apparently written by someone knowledgeable in entomology, appeared in the November edition of the same magazine. The writer had learned of plans for a state appropriation through a newspaper article in the *Boston Evening Transcript*, and his comments set the tone for many events yet to come: "The outcome of these efforts will be very

interesting. It is, at least, very improbable that every specimen in such a considerable area (about one and a half square miles, according to the article quoted) can be destroyed. The insect has probably come to stay, and, ultimately, the best way to keep it in check, outside of the artificial remedies, may be the importation of the parasites and natural enemies to which it is liable in Europe."[64]

The state Board of Agriculture paid for 45,000 copies of Fernald's bulletin and distributed them throughout Medford and surroundings. On December 6, 1889, the bulletin was published in the *Medford Mercury*. Fernald said, in part: "In this country [the gypsy moth] occurs only in Medford, Mass., and so far as I could learn at the time of my first visit to that place, it occupied an area in the form of an ellipse, about a mile and a half long by half a mile wide. This represents the territory where the outbreak occurred and where the insects were very abundant; but without a doubt they are distributed in smaller quantities outside this ellipse, but how far it is now impossible to tell."[65] Fernald did not consider himself linked to Medford's problems and regarded his part in events as incidental. As far as he was concerned, publishing the danger bulletin ended any association he may have had with whatever plans were being considered for dealing with the gypsy moth: "I simply performed a duty laid upon me when I accepted the position of entomologist at the Station here. I finished all the law requires of me when the Bulletin was distributed in that I gave the best methods possible for individuals to clear their trees and shrubs from the pest. By now the citizens of Medford petition the legislature for aid in destroying the insect, or to introduce parasites from Europe; it is no affair of mine."[66]

Still, Fernald clearly had a sense of foreboding about his role in the events that were now compounding, and on November 26 he wrote to Samuel Henshaw to inform him of the Medford selectmen's appeal to the state legislature: "If they do this, and the legislature grants their requests, it is possible that I may be consulted in the matter; and if it seems desirable to attempt to destroy these larvae with poisonous insecticides, I surely think some competent person should be in charge of the work which will probably occur in the months of April and May. . . . [I]f your other duties will permit of your undertaking the job, I will recommend you."[67] Henshaw responded on November 28 that he would undertake the work, and Fernald reminded him on November 30 that there was not yet any work to undertake.

He also revealed to Henshaw that the radical approach to the problem he had proposed contemplated not only the eradication of the entire species by spraying with poison but the suspension of some civil rights, and he was already making plans to thwart the opposition that he was certain would come:

> I did not advise going to the legislature for an appropriation in my Bulletin because that might have drawn opposition too soon, but I did advise the town officers of Medford to do it, as they are the interested parties, and I further urged them to get an act passed authorizing whoever does the work to go onto any man's land and shower the trees, for without a doubt there are cranks in Medford as elsewhere who might obstruct the work and forbid one from going on to their land unless the state legislature passed an act authorizing it.[68]

Fernald had become grouchy about his position and complained to Henshaw that for his work at the experiment station he was paid the "paltry sum of $500 a year" and might well to give it all up "at any time." He did not give "two shucks" about the gypsy moth affair but asked Henshaw to collaborate with him in stopping "the opposition of the Boston and Cambridge entomologists."[69]

On December 10, 1889, Dr. Martin appeared before the Medford selectmen on behalf of the road commissioners to ask that they request state aid in destroying the gypsy moth. The selectmen instructed their clerk to ask William R. Sessions what measures to take to bring the matter before the next meeting of the Massachusetts General Court, as the state legislature was called. Shortly thereafter, Dr. Martin discharged the workers who had been destroying egg masses because his small budget had been exhausted.

Fernald had returned to Amherst with the intention of continuing the preparation of a monograph on the North American Pyralidae, a work he had begun the year before, yet his role in the gypsy moth story continued to be a prominent one. The Medford selectmen repeatedly asked for his counsel on how to deal with the insects, and he always tried to accommodate them. On December 17 he wrote from the Hatch Experiment Station and formally advised the selectmen to request financial assistance from the state for this undertaking.

In private, Fernald could not have been as confident about his advice to exterminate the insect as he maintained in public. Neither he nor any other entomologist of his time could say with certainty that spraying alone would kill 100 percent of a given species, and nobody knew whether the moth's probable North American predators would prove effective. The only alternative plan on which he could fall back was one he had not recommended—to transplant the moth's natural enemies from Europe—though he had given some thought to the possibility and had mentioned eleven known parasites in his special illustrated bulletin published just a month earlier.

As the year drew to a close, Fernald wrote to Dr. Hagen—a man Herbert

Osborn called "the most learned entomologist in America"[70]—asking for information about the gypsy moth and about the possibility of importing predatory insects from Europe. Fernald posted the letter and went off to enjoy Christmas festivities with his family at their home on Hallock Street in Amherst. It was the holiday season, and the Fernald residence was a hub for social functions as well as a center for off-campus educational activities in entomology, since all the Fernalds were entomologists. The merriment this year would not be much different from that of years past, but life for the Fernalds and most of the people in eastern Massachusetts would no longer be the same. Fernald would never again set foot on a ship for Europe, although he did not know that at the time, and his work on the *Pyralidae* would not be started for another thirteen years.

[CHAPTER 4]

No Holiday Affair

With the new year celebration behind him, Fernald returned to his duties at Amherst to await word from Hagen. In his reply to Fernald on January 15, 1890, written in his awkward English, Hagen gave some bad advice at a bad time: "I myself have seen O. dispar many times in large numbers on property belonging to my father. I have helped kill them, for the next year, very few were left or found. Mr. C. F. Freyer, one of the most prominent lepidopterist in 1879 tells a similar story. A species as nearly related as O. moracha, is of course very dangerous, but a species attacking so many things is not dangerous. To import for O. dispar enemies from Europe, would make Massachusetts a laughing stock in the opinion of all scientific men in Europe."[1]

Upset with Fernald's danger bulletin, Hagen thought it was hastily prepared and sensational, and he did not like Fernald's plan to have the state "sprinkle [the gypsy moth] with Paris Green."[2] Fernald had fired off a letter to Hagen with the surprising demand to know where this statement had appeared in anything he had published.[3] A puzzled Hagen replied that it was on page five of the bulletin.[4]

Hagen's advice was based on his experience with the gypsy moth while he was a young man in Europe, and he did not grasp the probable course of events in America. His reputation gave much weight to his assurances that the gypsy moth might prove to be less terrifying than some had feared. Perhaps Fernald relaxed somewhat with the thought that the problem might not become too serious after all, and Hagen's words may have allowed him to feel more comfortable about the consequences of a failed attempt at chemical eradication. In any case, if importing natural predators would bring unfavorable review to the state and the new branch of economic entomology, then importation was even further out of the question.

The Calosoma Beetle

News of the gypsy moth outbreak was the subject of much discussion in the Department of Agriculture in Washington. Coleopterist Eugene A. Schwarz, a man Leland Howard considered the best entomologist in the office, and Bernard E. Fernow, chief of the forestry division, pointed out that an important adversary of the gypsy moth in Europe was the predacious beetle *Calosoma sycophanta*. European beetles of this genus had evolved a small leg spur that allowed them to climb trees with rough bark, and it was their habit to scale oaks in search of gypsy moth larvae. American Calosoma species also attacked gypsy moth larvae but did not have a similar spur and were thus unable to climb. Nothing came of these discussions because Charles Riley, chief of the bureau, was in poor health and absent from his desk for long periods, leaving the federal office of entomology without effective leadership.[5]

Fernald already knew about the beetle; it had been the insect foremost in his mind whenever he wrote to his European counterparts for information. Although the life history of the large and colorful Calosoma was not fully known during the 1890s, it was believed to live four years and prey almost entirely on the gypsy moth. It spent most of its life hibernating underground, emerging to become active during the larval stages of its prey and afterward returning to the ground. A Calosoma larva consumed about 41 gypsy moth caterpillars each year, a young adult beetle approximately 240 and a mature adult 270.

Through one of those unexplained adaptations of nature, Calosoma also attacked the pupae, though with a preference for cocoons containing females, which they devoured at a rate three times greater than those of males.[6] Since for every female moth destroyed, the next year's population dropped by about five hundred, just two beetles in a season's work might reduce the number of larvae by more than 125,000 the following year. That a relatively small number of beetles could have so dramatic an impact on the dynamics of population balance showed the appeal of natural controls.

Given the recent success with the lady beetle in California, the thoughts of many turned toward parasites. In January 1890, Riley and Howard published an article in *Insect Life* in which they listed twenty-four hymenopterous gypsy moth parasites of European origin. Soon after the article appeared in print, Riley received a letter from the Reverend Henry A. Loomis, then living in Yokohama. Loomis had read about the Massachusetts gypsy moth swarms and wanted to inform the entomologists of a parasite that kept the insect under control on the Japanese islands. He packed some of these insects in a small box and sent them to Washington. Although the parasites were dead when they arrived, Howard was able to identify them as *Apanteles fulvipus*, a

species of small wasp. Loomis made several more attempts to send living parasites to America, but all were unsuccessful.

The Act of 1890

The Medford petition for state financial aid was ready on January 15, 1890 (though the Massachusetts General Court had not yet convened), and was followed by applications from other moth-infested communities around Medford—Arlington, Everett, Winchester, Stoneham, Wakefield—and the cities of Malden and Somerville. Support for the petition also came from agricultural interests, including the Massachusetts Agricultural College, the Essex County Agricultural Society, and the Massachusetts Horticultural Society, groups that had been unnerved by reports that the new insect enemy devoured row crops. That fear persuaded Governor John Quincy Adams Brackett to bring the matter to the attention of the state legislature in his annual message of January 1890: "A new enemy is at present threatening the agriculture, not only of our state but of the whole country. I refer to the Gypsy Moth (Ocneria dispar), a European insect which has recently appeared in the state. They are said to attack almost every variety of tree as well as the farm and garden crops. . . . If their eradication is to be attempted, immediate measures are of the utmost importance."[7]

Members of the legislature's joint standing committee on agriculture visited the infested region early in 1890 and were shocked by what they saw in Medford. The walls of buildings, trunks of trees, posts and rails of fences, and even stones lying upon the ground were almost entirely covered with egg masses. (The famously fecund female moth's egg-stuffed abdomen is so big in proportion to the rest of her body that a later entomologist referred to her as little more than a sack full of eggs. One observer reported a case where a single female laid 1,400 eggs over a period of ten days.)[8] In addition to the uncounted numbers of egg masses the visiting committee observed, there were at least twice as many they could not see, for the female gypsy moth has a propensity for crawling into deep crevasses, squeezing beneath overhanging rocks, hiding under branches, disappearing beneath porch steps, or retreating into the openings between stacked firewood to lay her eggs; in short, she often deposits them where discovery would be unlikely.

On Monday afternoon, February 17, 1890, the committee on agriculture began hearings in the Green Room of the State House in Boston with the intent to secure what one local newspaper called "the extermination of the deadly gypsy moth."[9] Among those testifying were Nathaniel Shaler of Cambridge and Warren W. Rawson (the younger) of Arlington. Representative J. Henry Norcross of Medford subsequently introduced legislation for an

appropriation of $25,000 to exterminate the moth, supported by the amazing testimony given before the committee about conditions in the region. Board of Agriculture member J. W. Stockwell, who was in the hearing room when Medford citizens described events in their town, recalled that the testimony about conditions would be impossible for the average person to conceive: "If I could remember and bring it to you as it was given before that committee you would hardly believe it possible."[10] Leland Howard later reminisced that reading the testimony of the townspeople had reminded him of "the plagues of Egypt as described in the Bible."[11]

The legislative vote of approval was taken on March 14, 1890, under great pressure to expedite the process. The *Boston Evening Transcript* noted that the bill was rammed through "at express speed."[12] The full title of the legislation was "An Act to Provide against Depredations by the Insect Known as the Ocneria Dispar or Gypsy Moth." If one were constrained to fathom the thrust of the act from its language, rather than its history, one would conclude that the Massachusetts legislators did not understand the nature of the problem or the purpose of the act, for most sections were worded as if the menace at hand were a civil insurrection. One contemporary writer commented that the legislation "read like war documents."[13]

The act established and funded a commission to fight the moth, and one paragraph gave commission agents almost martial authority, allowing them to enter upon the premises of any person at any time, without a warrant, for purposes of insect extermination. Another paragraph removed the rights of citizens to refuse the commission and fined anyone who did. Property owners could sue for damages, but any award would be offset by the amount of any "benefit." The experts who defined benefits would have been the same ones who authorized the act, making it unlikely that any citizen would prevail in litigation or that any award would be very large. Another section provided heavy fines for citizens who knowingly transported the gypsy moth in any stage of its life cycle from an infested area into an uninfested one—punishment less severe but similar in concept to the penalty reserved for providing aid to an enemy in time of war.

A Campaign of Many Agendas

The small fraternity of economic entomologists did not need long to realize that the coincidental organization of their association, the appearance of the gypsy moth, and the formation of a state extermination commission presented them with a breathtaking opportunity for self-promotion. The best possible coincidence was that the infestation had occurred in Massachusetts, a small state of waning national influence and long past its prime as an agricultural

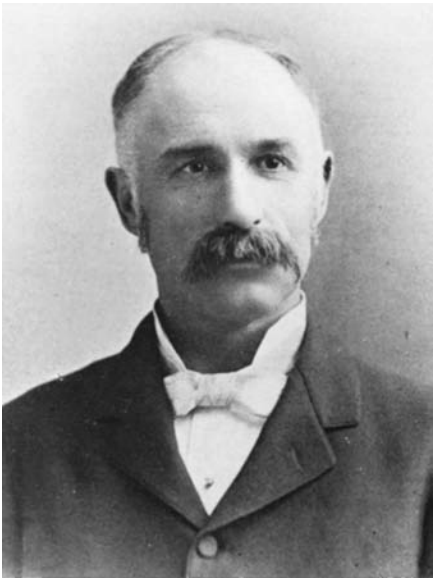
power. Still, the Commonwealth maintained a reputation as progressive in science and education and could now claim enough vision to recognize the need to deal with an insect problem and make an appropriation for that purpose. Fernald later wrote to Herbert Osborn that legislation against the gypsy moth would never have happened in any other state.[14]

Although the rush by economic entomologists to monopolize the situation was due to a fortuitous coincidence, most of this group knew from the first that there would be more to the undertaking than just killing gypsy moths. The passage of time revealed their three-part agenda: first, eradicating the moth; second, trying out ideas toward this end at the expense of the state; third, the advancement of economic entomology. Elated entomologists from the start referred to the proposed gypsy moth project as "the experiment" and saw it as a way to bring entomological work into both federal and state governments.

Despite the recommendation of Fernald, Shaler, and Sessions that the work be superintended by the Board of Agriculture, the legislature specified a commission that would report directly to the governor. Less than a week after the legislation was passed, Governor Brackett appointed a salaried commission of three men: Warren W. Rawson of Arlington, Pearl Martin of Medford, and J. Howard Bradley of Malden. Only Dr. Martin had even the slightest knowledge of fighting the insect. Rawson's appointment might have come about because Brackett was from Arlington and knew him personally. Rawson (1847–1908), known as "the younger" to avoid confusing him with his father, was a scion of one of New England's famous market-gardening families. He owned a successful seed store, was active in agricultural affairs, and held membership on the state's Board of Agriculture.[15] He was known for his contributions to greenhouse design and improvements in open-field irrigation systems. Rawson was the first to use heated greenhouses for commercial fruit and vegetable growing and among the first to use electric lights in his operations. His book, *Success in Market Gardening and Vegetable Grower's Manual*, self-published in 1887, reached seven editions and was republished well into the twentieth century.

Fernald was astonished by the appointments; he had simply taken it for granted that someone knowledgeable would be in charge, as he wrote to Henshaw: "I had supposed without any doubt that either our Director or Mr. Sessions would have been appointed on the commission, and in that case, it was my intention to invite you to take the entire charge and responsibility of the work and to pay you a liberal salary . . . but:—'the best laid plans of mice and men,' etc."[16]

News that the state commission would be composed of laymen dismayed the economic entomologists. Joseph Albert Lintner, state entomologist of New



Warren W. Rawson, the younger, in an undated photograph.
From *Biographical Review*.

York, felt that events in Massachusetts presented an opportunity that must not be lost. He wrote to Fernald that the idea of a lay commission operating without an entomological adviser was preposterous, and he wondered why Fernald had not been appointed chairman: "I supposed that, of course, you would have been chairman of the commission, and its controlling head, as you should have been. . . . I feel a deep interest in the matter, for the appropriation offered an excellent opportunity to test and show the value of economic entomology. If the experiment fails, it will stand in the way of obtaining state aid in other cases where it may be needed. It promises now to be a failure."[17]

On March 18 the first meeting of the new gypsy moth commission took place in Medford, a town that initially served as its base of operations.[18] Daily meetings were held until August 1, after which the commissioners met at least once a week for many months. As Rawson later said, "It required a great deal more work than we expected."[19] The commissioners decided to inspect the region and mark infested trees with pieces of red flannel. The original extent of the area thought to be harboring insects was a rather modest three-quarters of a square mile, a zone about half a mile wide by a mile and a half long, but the more the commissioners looked for signs of the moth's presence, the more they found.

They began their campaign on March 23 with a hastily assembled force of twenty men who claimed they could recognize gypsy moth egg clusters on sight. In three days they marked every infested tree they found in Medford,

Malden, and Somerville but burned egg clusters for only one day before being stopped by two days of heavy rain. The number of men was quickly increased to sixty, all of whom were issued kerosene torches. Rawson believed that if the weather held, his men could take care of the entire infested area in a week. But hatching time was approaching, and the commissioners knew nothing about poisons and spraying apparatus. Rawson often turned to Charles Fernald and Nathaniel Shaler for advice. Shaler favored a strategy of containment, whereas Fernald recommended that in addition to spraying larvae, egg masses should be scraped or cut from the trees and burned in kerosene.

The new commissioners were slow to realize the magnitude of the task that lay before them, but they were optimistic that even multiple infestations would not be hard to clear out. Rawson thought the moths would be under control the first year and mopped up the next year: "We have 60 men using torches and we can go over a large territory in a day when there are but few nests in each tree. And when there are large quantities of them [eggs] we shall burn the trees and all the territory near them. By doing so before they hatch out we will have the greater part of them burned up. Then when they hatch out we shall be ready for them."[20] The untrained men under Rawson's charge focused on little more than incinerating egg masses and applied themselves so assiduously that they burned one hundred barrels of kerosene in just a few weeks. The hot flames of the kerosene torches frightfully damaged many heavily infested trees. When not used on standing trees, the torches were turned on the ground to set fires that consumed the underbrush. Thickets were raked clean and burned, and acres of healthy trees were felled and set ablaze simply because they were covered with too many egg masses to remove. The worst news of the summer was that the insect had been found in the woodlands of the nearby Middlesex Fells, gravitating toward its natural forest habitat.[21]

Lintner wrote to Fernald again on April 7, urging him to find a way to take control of the events unfolding in Massachusetts. Rawson's commission was considering hiring as advisers entomologists in whom Lintner had no confidence, and he hoped that Fernald could still be appointed: "I wrote to [Chairman Rawson] . . . and further stated that it was quite discernible that persons acquainted with insects should be employed in the attempted extermination. I also expressed my regret that the commissioners had not seen fit to engage you to take charge of the work, as you were especially fitted to supervise it."[22] Lintner told Rawson that the work as than arranged could only result in failure, and later, complaining that Rawson had not replied, Lintner again reminded Fernald, "A failure in this experiment would militate against the cause of economic entomology."[23]

Fernald either did not realize that he was becoming hopelessly entangled with the pending gypsy moth campaign, or he lacked the will to state plainly

that he wanted no long-term entanglement with it. In his exchange of letters with Lintner he did not mention his reluctance to serve in any capacity. As entomologist of the Hatch Station, he felt unable to refuse the requests of the commissioners for his advice, and he likely thought that by supporting a solid candidate for advising entomologist, he could relieve himself of both problems with a single stroke. Fernald recommended Samuel Henshaw as the best choice, and in April the commissioners did interview Henshaw for the advisory position. Afterward, a dazed Henshaw wrote to Fernald:

> I went to Medford with [Rawson] and met the other members of the [commission]. . . . Mr. Rawson favored having [an adviser] and Mr. Martin did not see very much need of having one as he knew the gypsy moth as well as any entomologist, though he concluded that perhaps it would be "just as well to have one even if they did not follow his advice." It would have amused you quite a little to hear him say that the larva of the gypsy moth were not like that of the *caterpillar* and to ask what stage came after the caterpillar and if all insects came from eggs, etc.[24]

The meeting went well enough for Henshaw to suppose that he was hired, although the parsimonious commissioners did not broach the matter of payment for his services and could not agree as to whether or not they could afford an adviser. They invited Henshaw to discuss matters with them again at their next meeting, but Henshaw declined to attend, writing Fernald that he thought the three commissioners would be too much for him, and in any case he had no idea what his services were worth.[25]

Fernald doubtless saw the situation with the commission for what it was and—though with some apprehension at the thought of becoming further enmeshed with the gypsy moth commissioners—urged Rawson to visit Amherst and study the spraying apparatus kept there. The meeting was not reassuring. Fernald wrote to Henshaw that Rawson had stayed "about three minutes," and then left "probably [thinking] he has got all the information I could give him!"[26]

Nathaniel Shaler recommended a thorough inspection to determine the extent of the moth's expansion and advocated paying schoolboys a bounty for bringing in egg masses and caterpillars. The problem with this suggestion was that schoolboys would have to be trained to recognize egg masses and larvae. The commissioners feared that citizens, either in their zeal or out of ignorance, might spread the moths by improperly handling the eggs. Dependable help from the general public was doubtful, leading to the possibility that sufficient manpower would not be available when it was needed most.

The commissioners decided to proceed along the lines they had already laid out, inspecting areas where the moth was reported and marking infested trees with red cloth tags. As soon as the appropriation was released, employees hired by the commission were sent out to begin removing egg masses. It was a learning experience for all. The men developed effective techniques as they went and created specialized tools from experience and from the scant information Fernald could give them about the methods used in Europe.

The commissioners adapted Joseph Burrelle's recommendation from the 1840s on how to deal with the coddling moth in apple orchards: that is, banding tree trunks with cloth under which the larvae would be trapped, then handpicking the larvae and destroying them in an oven.[27] Later, workers hit upon the technique of scraping the trunk bark smooth in order to encourage the larvae into hay rope bands, and later still they discovered that raking and burning the ground clear of weeds and debris also improved control.

Workmen were issued large metal pails that each held about a peck, which they filled two or three times a day with egg clusters scraped from trees and walls. In places that were difficult to reach, such as crevices in walls and the undersides of fence railings, egg masses were burned with a large kerosene torch. A team of men entered Wellington Willows, an area not far from Trouvelot's old house, and found the willows covered with egg masses from the ground up; one resident described them as being "as thick as spawn in a fish."[28] The task of removing all the masses by hand was too laborious and expensive to attempt in the time available with the number of men employed, so the commissioners hit upon the idea of destroying the egg masses collectively. The field workers were supplied with axes, and all the beautiful old trees were cut down and burned.

These actions were taken in part out of desperation and in part because the commission was split on the subject of spraying; those opposed thought it was too costly and not effective. The editors of the *New England Homestead* faulted the commission for failing to secure competent advice and for wasting their energies scraping trees. They said that spraying with poison was the only "proper remedy, and must be employed notwithstanding the work already done," and that "the commission deserves public censure for adopting its own 'practical' plans to the exclusion of the known and simpler remedies approved by science and experience."[29] Fernald was delighted by this stance, which he called a "sharp rap on the knuckles," and he tweaked the commissioners by informing them that henceforth they must submit specimens of larvae for identification "to their own entomologist, Mr. Henshaw."[30]

The State of the Art

The commissioners subsequently bought fifteen new spraying machines for $75 apiece.[31] But the equipment with which Massachusetts went to war against the gypsy moth was primitive and unreliable, for most of the pumps for spraying trees had not existed long enough to prove themselves under conditions of actual use. The first of these "garden engines" to be designed for small trees was the "Florida" pump, manufactured in1880 by the C. J. Rumsey Company of Seneca Falls, New York, and it was not until 1889 that the Nixon Nozzle and Machine Company introduced its classic "Little Giant" and "Little Climax" pumps.[32] The only suitable spraying nozzle available at this point was the eddy chamber or "cyclone" nozzle, a misting device invented by William S. Barnard. Often called the "Riley" nozzle because Barnard was working under Charles Riley when he designed it, this spray head first appeared in 1880. It had been more or less perfected by 1885 and was then considered the best nozzle for tree work, even though it clogged frequently. About 1890 the French-made Vermorel nozzle was introduced. It was considered superior because blockages could be quickly cleared by means of an integrated pushpin.

Even the term "spraying" was so new that it was not in common use. The term "syringing" was applied to greenhouse work; "sprinkling" described applying liquid to low-growing row crops; and "showering" was used in reference to larger plants and trees. Although most of the pumps were not very powerful, a few of the larger ones could attain pressures of 160 pounds per square inch (psi). Once these were introduced for practical use, there was an immediate cry for pumps that operated at even higher pressures. The pump manufacturers were mystified by this turn of events. One said that of course his company could produce a machine capable of attaining 200 psi, but he could not understand why anyone would want to spray at that pressure, since all it would do was burst the hose.

The insecticides were no more reliable than the equipment that dispensed them, and at this time there were few to choose from. Paris green, made from arsenic mixed with the smokestack residues of copper smelters, often burned the leaves of plants. Its nearest and cheaper rival, London purple, burned the foliage even worse, and the efficacy of both these insoluble arsenical poisons varied widely and unpredictably. Contact insecticides consisted mainly of whale oil and soap emulsions, sometimes mixed with kerosene. Pyrethrum, an old standby made from chrysanthemum flowers, was too expensive to use except in greenhouses. Economic entomologists had so few options that Leland Howard of the federal bureau of entomology often bantered with Beverly

T. Galloway and others in the bureau of phytopathology about which of them had fewer remedies to suggest to their correspondents.[33]

Spraying began on May 12 under the supervision of C. A. Longley. Following Fernald's recommendation, the men used Paris green, some wearing backpack sprayers and the rest operating a new lightweight, horse-drawn apparatus intended for spraying orchards. The majority of the spraying was done in the Glenwood and Wellington sections of Medford, and Edgeworth in Malden, where—to paraphrase the commissioners—on Monday they would spray, Tuesday it would rain and wash the arsenic off the leaves, so Wednesday they would spray again, and Thursday it would rain, and so on. The constant spraying annoyed residents of the towns and became the biggest budget drain on the commission. The spraying was ineffective: one apple tree was sprayed fifteen times with Paris green in an effort to rid it of caterpillars.[34] But the commissioners later reported that the tree was not permanently injured by either the insects or the arsenic.

Owing to the limited period during which the insects were in larval form, spraying was completed by July 23.[35] Meanwhile citizens fought the surging masses of insect life as they had for the previous several years, with fire, water, and coal oil. Caterpillars were so crowded in some places that no part of the pavement could be seen between them, and they fell from the trees in such numbers that residents carried umbrellas on sunny days. On the roofs of many houses the presence of uncounted thousands of caterpillars resulted in so much excrement that it overflowed the rain gutters and plugged up the downspouts. In the densely infested Glenwood brickyard the workmen needed shovels to fill pails with larvae and the remains of pupae.

One Medford resident, Winslow W. Fifield, told of an old pump on his premises from which hung a bucket he used to water his horse. After moths fell in the water and drowned, Fifield said he could not rinse the bucket well enough so that his horse would drink from it. During the caterpillar season, the supply of foliage was sometimes so swiftly reduced that the caterpillars swarmed toward new food sources while they were still the size of ants. Fifield spent ninety minutes in the morning clearing his property, only to have to repeat the process at noon and again in the evening. He estimated that in four and a half hours of work each day he had destroyed millions of insects, "more moths than any man living," without causing an appreciable reduction in their numbers.[36]

Fifield's statement might have been disputed by J. O. Goodwin, who wrote of the problems faced by average citizens trying to protect a few trees on their small lots: "During the past week or ten days I have personally attended to the matter and have killed millions of Gypsy Worms which have congregated below the paper [bands] on my trees. . . . The number of worms cultivated on

three or four worthless trees on the premises next to my own is astonishing; numbers fail to convey an adequate idea. . . . [F]ifteen minutes after killing every worm to be seen on the trunk of the tree below the tarred paper, hundreds can be seen making their way up."[37]

Some men of the gypsy moth force carried only a hand whisk and a large metal pail. The larvae were so multitudinous that it was possible to sweep them into a pail up to the brim before any could crawl out. Kerosene was then poured into the pail and the contents set ablaze—whereupon the workman busied himself with other tasks because of the unbearable smoke and stink of cremation. Some of the infested towns were barren of green foliage by the end of the caterpillar season. J. W. Harlow had no raspberries or blackberries because the larvae had eaten most of the berry bushes.[38] Other neighbors had no fruit, as their apple and cherry tree foliage was consumed, and gardens were once again reduced to nothing but ravaged stems. It was a bad year to be a vegetarian in Medford.

On May 9, 1890, the commissioners reported to Governor Brackett that the infested area was "some sixteen times as large as at first represented," or about fifty square miles, and would require an appropriation at least twice as large as the original.[39] Brackett wrote to the General Court in support of the request on May 15, noting that the additional funds, if made available quickly, would save the state a great deal of money later on.[40] A supplemental appropriation of $25,000 was made by the state legislature on June 3, allowing the employment of enough extra workers to bring the field force to over one hundred men.[41] The inexperienced hires were employed for only thirteen days between June 16 and June 28, 1890, and thereafter most of the remaining men worked only until August 1. Workers entered the property behind Trouvelot's house, cut down every tree on it, and set one hundred acres of nearby brush afire. Later in the season the men returned to burn the brush a second time. Similar work took place in Arlington, Chelsea, and Everett.

Not realizing the threat of dispersion by wind, the commissioners feared only distribution of the insect by vehicle. Knowing that disturbed larvae would spin down from the treetops, they thought the caterpillars would crawl up the wheels of wagons from below and hide under the floor planks, but they soon discovered that most fell into the cargo from above when the passing wagons severed their threads. As patterns of infestation quickly appeared along heavily traveled routes of commerce, the commissioners took steps to prevent it. One hundred men were hired and designated as special police to guard the roads leading from Medford and Malden. For twelve hours each day these men, divided into squads of five, halted and inspected all outgoing wagons and destroyed any gypsy moth larvae they found.[42] The tool used for sweeping larvae off the tops of wagons and carriages was an ordinary house-

hold feather duster. The sight of officers crawling over the tops of vehicles and attacking little gypsy moth caterpillars with feather dusters was more than the average Massachusetts teamster could silently stand, but at a public meeting in December, Rawson gracefully defended the practice:

> We have had considerable fun made of us for keeping men upon the road with feather dusters to brush off the tops of wagons and carriages. That was an idea of mine. The commissioners found that certain teams were constantly going through this infested territory and stopping at a certain place, and there [we] found the gypsy moth. . . . All through the summer we made the owner of every brick team and every manure team provide a canvas cover for his wagon, so that it could be brushed off after passing through the infested district. In that way we have stopped the spread of the moths, and it was the only way we could do it.[43]

W. B. Harmon, the suffering soul who had gained himself a monumental headache when he bought Trouvelot's old shed and had it moved to his property at 55 Spring Street, endured the worst of the 1890 infestation. The moths had spread into the wooded areas north of his residence, and he could only watch as hundreds of thousands of caterpillars swarmed from this redoubt into his orchard and devoured every leaf of every tree in it, ruined all his fruit, and then destroyed his garden. Larvae crawled up the side of his house and clustered so thickly that no one dared open the windows or doors: "We could not step out of doors either on the grass or the walk without crushing the caterpillars under foot. Over our front door the house was black with them. . . . It is no exaggeration to say that there were pecks of the caterpillars under the door steps and on the fence. We had both the steps and the fence split up and burned to deprive the pest of its harboring places."[44] Several residents who lived through the infestation later recalled seeing Harmon's residence and that of his neighbor, a Mr. Plunkett, black with caterpillars and Postmaster Spinney's house on nearby Cross Street so thickly covered that "one could not have told what color it was painted."[45]

Medford and environs must have been quite a sight as the employees of the commission went about their business of "sprinkling" and burning, while homeowners did what they could. Many residents kept large metal cans, pails, or coal scuttles in their yards to receive the thousands of caterpillars they swept off their houses, brushed from trees, or picked each evening from porches, railings, and board walks. Scores of citizens brought pots of boiling water from their houses to scald the hairy crawlers on their fences, and soon the paint was blistered off most of the pickets in Medford. Others either

doused the insects with kerosene and set them ablaze or dug pits, raked the larvae in, and buried them alive.

In the dark of night the caterpillars could be heard eating leaves, and the sound of their excrement striking the ground sounded to some like the splatter of heavy rain. In a statement prepared later for the Massachusetts gypsy moth committee that replaced the original commission, Mrs. Thomas F. Mayo, who lived at 25 Myrtle Street next door to the old Trouvelot house, said: "In the night-time the noise of the worms eating the trees sounded like two sticks grating against each other. In the months of July and August I have gone out in the morning and raked up from under the elms a pile of leaves three or four feet high. These leaves had been cut off by the caterpillars, and usually there was a worm on the underside of every leaf. I would pour kerosene over the mass and set it on fire, and the squirming of the caterpillars would cause it to rise up as if it had a life of its own."[46]

The eerie flickering of gypsy moth funeral pyres in almost every yard illuminated sections of the streets at night, and an unpleasant, smoky stench floated constantly over the towns. Some residents talked of selling their homes and moving away, but no one who had been reading the papers would buy a house in Medford. By the end of July, after the spraying stopped, the force of workers had dwindled to about forty men still occupied with scraping egg masses from trees in the infested region. A few others filled cavities in trees that were observed to have harbored egg masses, and the remainder made a final, cursory inspection of the places known to have been infested.

In Washington, Charles Riley learned that the infested area was much larger than first thought and that no one knew for certain whether the moths had yet been contained. Riley was a practical man. Despite his inclination to poison these unwanted insects by the millions if he could, he understood that everything had changed and resigned himself to the idea that the great eradication campaign was over. As he wrote in *Insect Life* that September, "The territory occupied by the pest is much greater than was at first supposed, and extermination appears almost impossible."[47]

In Amherst, Fernald and his assistants were busy moving into a new experiment station on the campus of the Massachusetts Agricultural College. The building included a photographic studio, an attached shed, a glass house, and a large greenhouse in the Victorian style.[48] Fernald loved the facilities of the new building and thought there were none finer anywhere: "[My lab is] the most complete and fully equipped of any I have ever seen. [It] contains every good idea that I have ever seen in other laboratories and nothing has been spoiled by the fancy of the architect. In equipment we have everything needed or useful."[49]

On December 6, 1890, the last gypsy moth employee was discharged, and

the thrifty commission ended its work for the year with nearly half its $50,000 appropriation unspent. The commissioners now believed that the moth occupied territory twelve miles long and four miles wide. The fringe areas were scouted, and in only one place were moths found outside those limits. During the year, two tons of Paris green had been sprayed on approximately 70,000 trees. The first commission had done what it could, but the boundaries of the infested area were too great and the insects too numerous to be successfully countered by a small, inexperienced commission and a relative handful of unskilled workers.

A Secret Second Effort

As the season's work progressed, Shaler had become disillusioned with the Rawson commission and exasperated by its conduct. He thought the group did not give their duties serious attention, and the commissioners individually and collectively appeared not to comprehend the gravity of the task before them. Shaler no longer trusted their judgments when they believed the moth occupied just three towns, he said he knew it had spread into Somerville, Cambridge, Lexington, and at least nine other towns. Rawson, Martin, and Bradley's lack of vision had been incomprehensible to him, as had been their failure to notice the presence of the insects where the caterpillars were so obvious that, as he later said, "You could find [them] on almost any wagon."[50]

Shaler, unnerved by the appearance of the gypsy moth in his adopted state, was distraught over his inability to convey the urgency of the situation to Rawson's group. He saw a divided and rancorous bunch that lacked leadership and would not listen to advice. He had recommended a thorough inspection, but none had been made; he had pleaded for containment of the moths by cordoning off the infested areas and then driving the invaders inward, but the commissioners had done just the opposite. Commission employees were hired without screening and sent into the field with few tools and no training. The proficiency of the men with arsenical poisons was notable by its absence.

Shaler told Fernald that he "had the ear" of the governor-elect, William Russell, and would present the matter to him privately, causing Fernald to hope for a quick reorganization of the commission.[51] Fernald had recommended hiring an adviser, but the commissioners dawdled for so long that the one individual who was interested changed his mind. Riley, in his presidential address to the second annual meeting of the Association of Economic Entomologists in November 1890, said that the extermination effort in Massachusetts "threatened to become farcical," and it was only through good fortune that the work proved as successful as it had.[52] The scientific community was

incredulous and the average citizen distressed by the commission's doings. Riley observed that the commission was unpopular and its work "severely criticized."[53] Sessions, convinced that the insect was nearly invincible, believed that the war to stop its spread should be one without quarter:

> This creature feeds upon the foliage of almost all our deciduous trees and shrubs, as well as upon the crops of the farm. Its power of multiplication seems almost without limit. If it cannot be entirely stamped out, it will be forever a menace not only to the crops and trees of our state, but to those of the whole continent. I desire to again record my sense of the importance of earnest work by those in charge of the matter. Scientists all agree in believing that, if it is possible to extirpate the pest, it should be done, let the expense be what it may.[54]

At a public meeting held in Worcester on December 2, 1890, Commissioner Rawson, attending as a member of the Board of Agriculture, was asked, "What is the prospect for success in the campaign against the gypsy moth?" From Rawson's answer, one can see that the gypsy moth commissioners considered the matter well in hand and the worst of it over. They were proud of their parsimonious handling of the state funds entrusted to them: "We took as the basis of our experiments [in killing moths] the experience of the Agricultural Experiment Station at Amherst, or the professors there, in spraying the trees with Paris green. We asked and secured, as many of you know, an appropriation of $50,000. We shall have expended at the end of the year about $30,000 of that appropriation. I do not think we shall require so large an appropriation another season."[55]

Many citizens at the meeting, however, regarded spraying as ineffective, since they had seen that Paris green was useless against late instar larvae. There were complaints from the public, anger over the spraying of private property, and ridicule of other efforts to exterminate the moth. There were also serious complaints about the competency of the fieldworkers and the commissioners, and rumors had begun to fly that the commission had mismanaged the effort and misappropriated state funds.

The gathering was rather lively, and one gets the sense that the average farmer and estate holder in Massachusetts did not view the potential severity of the infestation with the same dread as did the Board of Agriculture and the economic entomologists. Their attitude was a slap in the face to Sessions and showed him that in addition to fighting the moths, the board would also have to fight the public's apathy and bestir the farmers and landowners to action. The thought of such indifference made him angry, and he used the meeting as an opportunity to underscore his point:

> I hope the sentiment of the [agricultural] community will be made manifest to the Legislature, that we want the campaign continued and we want it continued in the best possible manner. This is a big fight; this is no holiday affair. If this moth gets away from us, the whole country must suffer. . . . [The commission] will not limit their efforts to the use of paris green, but they will resort to any other method which seems likely to produce the desired results in the destruction of these pests. They adopt the motto of an Irishman in a fight, "Wherever you see a head, hit it."[56]

[CHAPTER 5]

Preparations for War

NATHANIEL SHALER, now committed to injecting himself forcefully into the gypsy moth campaign, had one last obstacle to overcome: the support Rawson enjoyed because of his friendship with the Republican governor, J. Q. A. Brackett. Shaler's opening came when Brackett left office after serving a single year and was succeeded by William Eustis Russell, a thirty-four-year-old, reform-minded Democrat and Harvard graduate. Shaler knew Russell personally and after attending his inauguration in early January 1891, he met the new governor on the street in front of the State House. He expressed his concerns that the gypsy moth commission was a divided, rancorous, and inexpert group under suspicion of corruption and mismanagement. Russell said he had already decided to appoint a replacement group with Shaler as chairman. Startled, Shaler replied that he would not accept the responsibility unless the legislature put the work under the Board of Agriculture.[1]

At its annual winter meeting in Boston on February 3, 1891, the Board of Agriculture "voted on a motion of Nathaniel Shaler that a committee of three be appointed by the Chair to represent the board in matters of legislation and agitation concerning the destruction of the gypsy moth."[2] The motion passed, and Shaler, representing Martha's Vineyard, was appointed to this lobbying committee along with Francis Henry Appleton of Peabody and S. B. Bird of Framingham. The purpose of this committee was to wrest control of the gypsy moth campaign from Rawson, Martin, and Bradley by convincing the governor that establishing a new commission under the Board of Agriculture would be the best course of action for the state. Shaler's group contended that Rawson's commissioners had conducted themselves improperly, were incapable of handling the task entrusted to them, evidenced conflicts of interest, and displayed other faults serious enough to warrant their removal. They argued that the proposed replacement group would be superior even if it consisted of men as inexperienced as Rawson's who would be advised by the same entomologist Rawson had used.

Shaler, Appleton, and Bird submitted a report assuring Russell that in

Nathaniel Southgate Shaler.
Photo courtesy Ernst Mayr Library of the Museum of Comparative Zoology, Harvard University.

proper hands the problem with the gypsy moths would disappear. They argued that an unpaid committee would save the state $4,000 each year and that the "evil" insect was an agricultural pest that should be dealt with by people familiar with agriculture. Shaler stated to the governor in his special communication that a committee appointed by the Board of Agriculture and aided by "proper experts" could quickly and efficiently deal with the danger.[3] Russell may not have been as knowledgeable about the state of affairs as some thought, and he perhaps received a one-sided perspective from Shaler. His response shows that he did not even know the correct name of the insect, which he called the "Egyptian moth."[4]

Charles Fernald's part in all remained advisory in nature, although it would be to his advantage if the commissioners were ousted and the work placed under the Board of Agriculture. The community of economic entomologists had been encouraging him to take control of the campaign, since Rawson's commission had not employed an entomological adviser. The replacement of the original commission was a second chance that had fallen into their laps, one that would serve to advance their agenda and allow one of their own to be in a position of authority.

Russell had written to Rawson on January 23 asking him to explain what had been going on and noting, "The Commission is one placed by statute under the control of the Governor, and therefore one for whose work he is

directly responsible."[5] In response, Rawson prepared a special report detailing the year of work and sent it directly to the governor without showing it to anyone else. Unlike all the accounts that followed, it was never published, and it has not survived.[6] Its contents must have confirmed the governor's suspicions, however, for on February 20 he sent a notice to Rawson alleging six counts of improper conduct: first, that disharmony had obstructed and delayed the work and that plans had been put into effect and contracts entered into without consideration by the full commission; second, that commissioners had sold goods to the commission at fixed prices and also fixed the contract price for teaming and livery; third, that blank payroll forms had been signed and filled in later; fourth, that commissioners had knowingly overpaid for horse teams; fifth, that a commissioner had used men employed by the state to circulate brochures for his private business; and sixth, that spraying had gone on all season despite its cost and even though the commissioners had no idea whether the procedure was proving useful and, in fact, were bitterly divided on the issue. Governor Russell wanted answers to all these allegations, and he wanted them in less than four days.[7]

While the commissioners prepared their response, the state auditor reviewed their books and found that acts of financial misconduct had indeed occurred. From powerful agents of the executive branch and respected members of their communities, Rawson, Martin, and Bradley had become lawbreakers who faced the prospect of a thousand-dollar fine and a year in jail. They responded to the governor by the appointed hour on February 24, however, and suffered only embarrassment for their misdeeds. The next day Russell dismissed them all, abolished their commission, and ordered them to turn over their papers and property to William Sessions.[8] The same day, Russell sent a four-page letter to the executive council of the General Court in which he outlined his reasons for creating a new commission and revealed the admissions of the original commissioners. In addition, he sent a special message to the legislature nominating Sessions, Shaler, and Appleton as commissioners locum tenens, noting that these nominees wished to serve without compensation.[9]

Sessions, Shaler, and Appleton, who had agreed to serve for six weeks until a new commission was created, were dumfounded when Russell said he expected them to constitute the permanent committee, but it should not have surprised them that Russell would proceed along this line since the Board of Agriculture had insisted from the start on having the work under its control. Sessions later testified he had protested strongly against having the board do the work, and that the governor had removed the first commission for reasons known only to him.[10] His recollections contradict Russell's statement that the

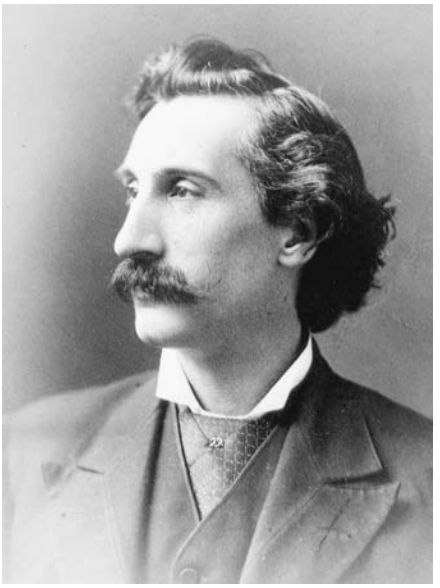
conditions of the appointment were made in accordance with the wishes of the appointees and are contrary to Shaler's statements that he and Sessions had lobbied personally for the change.

Shaler later said he would not have accepted his commission had it been a permanent one, but that he was proud of his part in removing Rawson's board and believed it was a feather in his cap to have helped abolish at least one commission in Massachusetts.[11] Many others also were relieved by the removal of the Rawson Commission, and J. G. Jack of the Arnold Arboretum summed up their reasons:

> The results arrived at in reducing the pest last season were better than many people anticipated and as good as was to be expected from inexperienced and more or less careless management. Land-owners naturally made much complaint and opposition to the invasion of their grounds by employees of the Commission for the purpose of searching for the cocoons of the Gypsy Moth, or more particularly for the application of insecticides (chiefly arsenical) to trees, shrubs and other vegetation. The act establishing the Commission gave it power to invade any private place in furthering its object, and the ignorant workmen employed were in many cases apparently very careless in the use of the Paris Green and indifferent as to the thoroughness of their work.[12]

The act of March 14, 1890, was superseded by the act of 1891, chapter 210, which increased the authority of the commission. The new commissioners had received their charge of duties on March 4, 1891, at a conference set up for that day at the Board of Agriculture offices in Boston. Four distinguished entomologists, Charles Valentine Riley, Charles Henry Fernald, Samuel Hubbard Scudder, and Samuel Henshaw, had been invited to appear and make recommendations to the commissioners, although Henshaw was unable to attend. Prominent citizens and elected officials of all infested communities had also been invited, and many were present, including Mayor Wiggin of Malden, Selectman L. S. Gould of Melrose, Selectman W. C. Craig of Medford, and Warren A. Peirce, a civic leader and coal merchant of Arlington. Present in addition to Shaler, Appleton, and Sessions was Edward Howe Forbush, awaiting his official appointment as director of fieldwork. Conspicuous by their absence were the original commissioners, Martin, Bradley, and Rawson. The incoming commissioners had not spoken with the outgoing commissioners before the meeting, so no one in the room had a clear idea of the details surrounding the task ahead of them.

Shaler, about fifty years old and at the height of his intellectual powers, is



Charles Valentine Riley, circa 1886.
Special Media Services Division, National Archives & Records Administration.

known to history as an eminent geologist, zoologist, and prolific writer on a wide range of subjects. He had been Leopold Trouvelot's colleague and friend and was familiar with the gypsy moth infestations occurring nearby. Shaler was a tall, athletic, and sinewy man with steel-gray hair and beard.[13] Author David Livingstone described him as a man with "feverish vitality"[14]—perhaps a symptom of the emotional instability that had occurred a number of times during his life. He had suffered collapses from an unnamed mental condition in 1866 and again in 1872, and recovery from each had required more than two years. Recuperating from one such bout in Europe during the summers of 1866, 1867, and 1868, Shaler had encountered examples of gypsy moth defoliation, and the recollection of those sights haunted him.[15]

The star entomological adviser to the new commission was Charles Valentine Riley, forty-seven, chief in entomology at the U.S. Department of Agriculture. Riley was a man of medium height and build, whose longish, wavy hair, handlebar mustache, and mode of dress were in keeping with his reputation as a flamboyant and volatile artist.[16] Although he was self-trained, Riley was a respected but highly controversial entomologist who was nearing the end of his luminous career and was in poor physical and emotional health. He was often absent from his desk in Washington and spent months at a time in Europe, ostensibly on entomological matters. He was plagued with frequent headaches, was unable to concentrate, and suffered from periods of debilitating chronic insomnia. He had wide mood swings and could easily be either

confrontational and argumentative or convivial and charming. One modern chronicler believes that if Riley had lived at the end of the twentieth century, he would have been diagnosed with bipolar disorder.[17] Howard wrote of Riley's condition at the time: "He could sleep on a long railway journey, . . . [or] in a barber's chair [better] than he could sleep in his own bed at home. It seems not to have occurred to him to install a barber's chair in his house, but after a sleepless night he would often go to the barber and pay by the hour for a chance to make up lost sleep. All this must have affected his disposition seriously."[18]

Another adviser was Samuel Hubbard Scudder, fifty-two, a fossil entomologist and an eminent authority on Orthoptera and Lepidoptera. Like Shaler, he had been a student of Agassiz, and he is still known today for his extensive and sometimes controversial contributions to insect classification. He is remembered as a man who was perpetually behind schedule because of his penchant for overextending himself even more than Shaler, who was famous for it. Scudder is also remembered for a memorable account, written in 1874, of three days spent studying a pickled fish under the tutelage of Professor Agassiz.[19] Howard called him "a delightful, scholarly man, and a charming writer" and one of the most distinguished entomologists of his generation.[20]

Charles Henry Fernald was also present at the meeting. Approaching his fifty-third birthday, he was then in good health but had suffered from lifelong asthma and was susceptible to severe and prolonged illness from colds. Many letters written to him during the 1890s include wishes for his speedy recovery from influenza and similar ailments, and the slightly shaky hand noted in his replies was a sign of incipient rheumatism.

Civil Warriors

Many of the participants in the room were middle-aged veterans of the Civil War. Fernald had served as first mate on the steamer *Housatanic* and later as ensign on the ironclad monitor-class ship *Patapsco*; Appleton was a brevet general; Riley had been a private in the 134th Illinois Volunteers; Shaler, a Unionist, had been captain of the Fifth Kentucky Battery; and Sessions had attained the rank of sergeant in the Forty-sixth Massachusetts Infantry. Others in the room who were not mentioned by name in the stenographic transcript had likely served the Union cause as well.

The influence of the war on these men and on the subsequent course of events cannot be ignored. The entomologist Stephen Forbes probably described the feelings of all Civil War veterans when he wrote that the young soldiers had been molded like "lumps of hot iron between jaws of cold steel."[21] Livingstone notes that the war's events had "a deep effect" on Shaler and left

him with a "predilection for military history."[22] Service in the War between the States taught men lessons they drew on all their lives. Among these was an acceptance of the need to do terrible things in pursuit of triumph; victory in war was the single greatest example of an end that justified the means.

The participants with agricultural backgrounds would not have thought much differently in this situation than did the war veterans; they also understood that a stark threat required a stark response. Many surely remembered the episodes of the devastating livestock disease pleuropneumonia that had occurred in Boston and vicinity in the 1870s, and that the method used to eliminate it was slaughter. The same tendencies to think of the proposed campaign as a military one was unmistakably exhibited by members of the General Court when they drafted the legislation against the moth. Insect problems were nothing new to farmers of the region, who had been dealing with the Hessian fly, the chinch bug, the Colorado potato beetle, and the plum curculio. Yet the argument persisted that there was something different about the gypsy moth, and the response to this invasive insect was unprecedented. For the first time in the nation's history, a well-funded and well-organized program, initiated and controlled by the state, would send an army against a nonhuman foe. It was nothing less than total war against an insect on a scale never before seen or contemplated, and one for which military experience would be an asset.

A modern military truism is that in times of crisis men do not rise to their occasion but fall to their level of training. With no precedents to guide them, the old soldiers in the room could not help but think of the coming engagement in the same terms as a military one against a human adversary, and they began to plan for a contest in which there was territory to be regained, fronts to establish, counterattacks to mount, and an enemy to besiege. The fog of war was already closing in. Little was known about the insect's habits, and to worsen an already bad situation, the information available indicated that the moth in America was exhibiting behavior unknown to European entomologists. The existing situation was unclear, the boundaries of the infested region were uncertain, and there were disturbing reports that the invader had already reached western Massachusetts and southern Maine.

One does not have to imagine what was on Shaler's mind as the participants gathered in the room. A complex and multifaceted man, he was pulling together some widely separated facts and reaching some disturbing conclusions. He understood that the frontier era of American history had come to a close. The westward expansion that had been occurring throughout his lifetime had ended. There were no more virgin fields to plow and no more pristine forests to log. Shaler believed that the conservation and protection of natural resources would become increasingly necessary, and he saw this need arising

first in the nation's woodlands. Gifford Pinchot, a man sparing in his praise of others, later said that no one spoke about the forest with greater authority than Shaler.[24]

In his book *The Forests of North America*, published in 1887, Shaler had expressed the view that the sheltering and providing forest was the cradle of Western civilization. He now contended that the moth's destructiveness, if left unchecked, could destroy all the forests on the continent and even bring down civilization, and his reputation was so impeccable that not a single man in the scientific community challenged this conclusion. Shaler believed that the power of the gypsy moth to cause damage in America exceeded that of all other insects combined. He believed that locusts had reduced North Africa, once called the granary of Rome, to a barren country, causing enough damage to alter the course of history, and he saw a parallel with the gypsy moth: "The startling change which has occurred along the whole southern coast of the Mediterranean within 2000 years, which occurred shortly after the Christian era, the pauperizing of that country, was accomplished by an insect. Seeing what I saw about Medford when the [gypsy moth] went unhindered, I came to the conclusion that if it made ravages of that nature, that scope, over this country, it might break down our civilization."[25]

As chairman, Shaler opened the meeting with remarks in which the normally genteel Kentuckian faulted the previous commission for allowing the moths to expand their range: "I begged [the commissioners] to bend their energies to bringing in the boundaries [of the infested area] as far as possible, to pay the market price for eggs and grubs, and to put their inspection work in progress; but they went into a miscellaneous sprinkling and burning over the whole territory. The result now is that, as nearly as I can ascertain, it would take a line thirty miles long to enclose the area the insects occupy."[26] As far as Shaler could surmise, the insect was abundant in an area of ten square miles and was scattered within an area of about fifty square miles. Since its females could not fly, its main forces moved outward at a slow rate. Its egg clusters were largely laid in the open and were vulnerable eight months of the year. The city of Boston and the Charles and Mystic Rivers prevented the enemy from deploying farther south, and the ocean blocked its eastward retreat. With the insect concentrated along roads where the nozzles of heavy spray equipment could be brought to bear against it, the odds of a successful extermination seemed high.

Fernald also held to the idea that the insects had not spread into the forests and would be within easy reach along the roadsides: "As the moth is distributed in great measure by vehicles, it makes its first appearance where the teams stop, and begins its work of destruction in the door-yard, orchard and garden.

Thus the danger to the forest, in case the moth were allowed to propagate unchecked, would be comparatively remote."[27]

The conviction with which Shaler and Fernald made their pronouncements had a pivotal influence on Riley, and it was Riley who gradually commanded the greatest attention during the conference. His reputation was due in part to his position with the Department of Agriculture but even more to his record of practical experience. Fernald may have known more about moths, and Shaler's expertise about forests may have been greater, but no one had more experience than Riley when it came to handling big problems in the field. But he was ambivalent at first; as he responded to a question from Appleton: "Is it practicable to exterminate it or not? . . . I have serious doubts, because if it may be said to occur in an area of say fifty square miles, if it is found even in a number of central points of distribution in that area, there is great danger. . . . [M]y own fears would be that it has got into the woods and on trees that are not so easily treated."[28]

Riley asked several times if anyone knew whether the moths were in the woods or not, and Shaler reassured him that they were "still confined to the artificial grounds," meaning trees and crops under cultivation and domestic plantings and gardens around residences.[29] The position taken by Shaler and Fernald was astonishing because it was totally speculative. There was a good reason why nobody knew if the moths were in the woods or not—nobody had looked! Fernald had limited his inspection to a single day in the populated parts of Medford, and the only other survey had been a haphazard affair attempted the year before by a small number of men under Rawson's commission, who scouted areas along the streets and central sections of towns already known to be infested.

Riley, asked to give dispassionate advice, briefly touched on many important points including quarantines, parasites, spraying, and destroying egg clusters. He doubted that exterminating the insect was possible, given the size of the infestation, but nevertheless covered his bases thoroughly. In contrast, Fernald remained singular in his support of extermination. He kept pushing the idea, saying it would be "highly desirable" to stamp out the insect. That such an attempt might not succeed did not seem to trouble him, and at one point he stated that if extermination failed, other methods could be used to contain the moths. Even Riley soon warmed to the idea of eliminating the invading insects. As the meeting progressed, he became less a detached adviser and more a passionate advocate for war, falling in with Fernald's idea of extermination. He understood that an opportunity for the new scientific branch had presented itself, one that, if skillfully handled, would provide the lasting glory snatched away despite two earlier successes: the results of the

U.S. Entomological Commission's study of the Rocky Mountain locust in the 1870s, and the use of natural controls to clear the California citrus groves of the cottony-cushion scale insect (*Icerya purchasi*) in the late 1880s.

During the worst of the citrus scale infestation, Riley had learned of a parasitic fly in Australia that attacked the scale. Prevented by congressional action from going himself, Riley sent Albert Koebele to Australia instead. Koebele stumbled upon the Vedalia beetle (*Rodalia cardinalis*) while looking for the fly and realized the importance of his discovery; within a year the beetles brought the scale under complete control. But the California success was in many ways more serendipitous than scientific. Still, Riley had been at the center of this highly visible triumph and was so proud of his part in it that he named his first child Cathryn Vedalia Riley.

The earlier work on the Rocky Mountain locust had been a first-rate piece of scientific investigation. The commissioners had discovered the breeding grounds of the locust, identified the insect as a separate species, determined the conditions causing outbreak years, and predicted how long the swarms would last. Before any of the findings could be put to practical use, however, the insect became extinct. Still, in the minds of many the elimination of this fearsome scourge could be attributed to the work of the commission.

As a result of such events, economic entomologists found themselves arguing against their greatest successes. The conditions surrounding both endeavors had been so singular that no eastern entomologists believed they were likely to happen again, but the public remained unconvinced. The idea that problems with insects on a grand scale could be solved quickly had resulted from the Rocky Mountain work, and the value of natural controls had been strongly impressed on all those who knew about the California success. A test for economic entomology that was free of capricious factors was needed, and in this respect no insect could have served better than the gypsy moth.

Legions of *Hypogymna dispar* rampaging through Massachusetts presented staggering implications. Everyone in the room already had seen that the insects would swarm through fields and orchards, devouring foliage to the last stem and twig, and Shaler had voiced his fears that when the larvae had done their worst in the orchards, the great eastern forests would fall next. The insect was known to attack row crops in Europe; thus a consuming march of caterpillars threatened the vulnerable American midwestern plains—a lush agricultural prize. The presence of the gypsy moth justified the existence of economic entomology and fulfilled the prophecy that a great war with insects was looming. All that stood between mankind and the alien hordes were a few brave economic entomologists. If they could stem the tide, no one could doubt their value, and the science of economic entomology would no longer be regarded as a backwater discipline for second-rate scholars.

Riley, like many of his colleagues, believed that with the establishment of the experiment stations in July 1888, a "new era" had begun in economic entomology.[30] One suspects that he intended to take part in another great success story but had not yet made up his mind between natural control and chemical eradication. The California episode had split economic entomology and resulted in a near-brawl over who deserved the most credit, a problem that Riley was not going to let happen again. He attached so much importance to the meeting that he hired a stenographer at his own expense to make a record of everyone's comments for publication and posterity.[31]

Assuming that gypsy caterpillars would succumb to spraying as easily as tent caterpillars and canker worms, Riley based his plans on Shaler and Fernald's questionable hypothesis that there were no caterpillars in the woods. Given an appropriation of $100,000, he saw no reason why the insect could not be exterminated with a single spraying campaign that would last no more than four weeks. Riley had much faith in the effectiveness of spraying arsenical pesticides such as Paris green, and argued that if only roadside trees needed spraying, a spectacular kill could be achieved. Such a triumph would be a showy debut for chemical entomology in New England, especially if done right before the eyes of the citizens, so Riley argued not only for a course he thought would be the most effective, but also for one that would be the most conspicuous:

> Individually I have always felt, and so expressed myself, and still feel, that the proper way would be to use whatever funds the state will give you during a limited time, and concentrate all effort and all expenditure in the month of June on the destruction of the caterpillars, and not to bother about the destruction of the eggs or the prevention of the spread of the insect . . . Therefore, as a single spraying will kill five thousand caterpillars just as well as one, there is nothing to be gained by the work of destroying the eggs.[32]

Although spraying devices were becoming available through commercial channels at this time, there was no corresponding apparatus for attacking moths in their egg, pupa, or imago stages, thus limiting all options for mechanized attack to the larvae. Work against the insect in any of its other three life stages would have to be done by hand. None of this mattered to Charles Fernald, who thought the moths could be eradicated wherever they were found. As far as he was concerned the effort would be made for extermination only, and it would be done with chemicals. He knew that in order to ensure a continuing stream of appropriations, the campaign would have to be carried out in a certain way, and the history of the campaign reveals what he had in

mind. His rationale was that a complex condition represented only an accumulation of simple conditions; thus, if it was possible to destroy insects on one tree, it was possible to destroy them on all trees. "Defoliation," "extermination," and "eradication" would become terms with indistinct and flexible meanings. Ridding the Commonwealth of the gypsy moth would be presented not as an uncertain task but as a simple matter of time and money. In keeping with the approach of economic entomology, the practical work would be accomplished through a marriage of business, science, and the state.

All parties would emerge from the battle with something they wanted. The state would be rid of the moth and admired by other states for its progressive leadership stance. The Board of Agriculture, which had long been little more than a record-gathering organization constituted with volunteers, would take a large step toward becoming a powerful administrative and regulatory body. Practical entomology would triumph over not only the insects but also the impractical branches of entomology. Other states would follow suit against their insect enemies, creating many new jobs for economic entomologists. Science and technology would defeat the enemy, and chemicals delivered by human hands would prevail over the unreliable and capricious techniques of natural controls. Sprayers would work where prayers had not: poisons would replace predators.

One can imagine Fernald in the conference room as he introduced his theories of extermination, speaking in a voice so soft and silky that Peters said it came very close to sounding feminine: "Suppose we have a tree like the elm I see yonder, and suppose we know it to be the only tree in America that is infested. I think you will all agree with me that for a small sum of money all moths on it could be destroyed. Suppose there were two,—suppose all the trees on the Common were infested. If they could be destroyed on all those trees, it is only a question of time and money to eradicate them from a much larger territory."[33] While Fernald outlined the approach of economic entomology and expressed the challenge it must meet, he still considered himself as a participant only to the extent required by his duties as entomologist of the Hatch Station. He served notice that he did not want to participate in the process over the long term and suggested that the commissioners hire someone else as their entomological adviser. He agreed with Riley that the size of the territory to be treated was "stupendous" and treating it an unprecedented experiment, but he put his reputation on the line by stating his belief that the insects could all be destroyed.[34]

Samuel Scudder, who had not embraced economic entomology, entered the meeting room late. His intellect and personality were markedly different from those of the others in attendance. Clinging somewhat to the old school, he had been among the last of the era's great entomologists to accept Darwin's

theories of evolution. Now, although he had not heard the remarks made earlier by Riley and Fernald, he had already given some thought to the gypsy moth problem. When Shaler asked him whether it would be better to collect egg masses or spray larvae, his response came out in a rush:

> The caterpillar is a very liberal feeder, so, of course, it is very much more difficult to reach by spraying, because the spraying is not to be confined to a few kinds of trees, but to a very large number, so that one would say you would have to spray almost everything you came across. So with the eggs, which are laid not always on trees, but on almost anything else. . . . [I]t seems to me that nature has indicated the easiest means of attack. The eggs are laid in batches, and are exposed for eight months of the year. Therefore it seems to me that the egg is the place to attack.[35]

Riley, becoming increasingly excited about the thought of a grand confrontation, strongly disagreed with Scudder. He urged that the state of Massachusetts "make the experiment" of eradication. He believed that if spraying could not kill the caterpillars, the only recourse left would be clear-cutting the entire Middlesex Fells. "It pays better," he said prophetically, "to make one grand effort than to fritter your energies away over a number of years, and then fail."[36]

Riley may have abandoned natural controls as the primary means of subduing the gypsy moth because there were at least two obstacles across that path. The first was the language of the state legislation, which called specifically for extermination. The second was the practical matter of finding natural predators of a foreign insect. In 1886 the U.S. Congress had restricted the search for biological insect controls to the United States and in 1888 attached a rider to the Agriculture Department appropriations bill prohibiting federally funded foreign travel for department employees. This proviso had been aimed at Riley in retaliation for his long visits abroad each year on the taxpayer's dollar while ostensibly in search of entomological information. Restricting the search to the United States would make the chances of finding predators or parasites of the European gypsy moth a frustrating, probably futile, exercise.

Alternatively, a hunt for foreign predators could be paid for by the state of Massachusetts. Such a search might become a costly proposition, but Riley understood that if the eradication program fell short, the state would eventually be forced to approach the federal government for aid much as the California Board of Horticulture had done in its struggle against the cottony-cushion scale. If Massachusetts had to battle the gypsy moth alone, Riley thought the easiest way to win that battle would be with chemical insecticides, not with

other insects. He warned the commissioners to make their first effort their best. A failure would make it difficult to get another appropriation from the state, in which case help from the federal government could not be expected. As he had told the Californians two years earlier: "I would not hesitate, as United States Entomologist, to send someone [to a foreign country to search for predatory insects] with the consent of the Commissioner of Agriculture, were the means for the purpose at my command. But, unfortunately, the mere suggestion that I wanted $1500 or $2000 for such a purpose would be more apt to cause laughter and ridicule on the part of the average committee in Congress."[37]

The resistance met by Riley was more than just the reaction of a spiteful congress to a flamboyant entomologist. The passage of the Hatch Act, creating state agricultural experiment stations, was seen as the capstone of a process that had begun in the 1860s with federal help in establishing the land grant colleges. Many legislators believed the act satisfied any responsibilities the national government may have had to individual states in matters of agriculture. The prevalent theory of the time was that of laissez-faire, and the distance between the federal and state administrations was kept wide to prevent development of a paternalistic central government with dependent states. The tone of the times was typified by President Grover Cleveland's famous refusal in 1887 to sign a bill that would have provided federal money to help drought-stricken Texas farmers buy seeds; the reasons he gave could easily have applied to insect problems:

> I can find no warrant for such an appropriation in the Constitution, and I do not believe that the power and duty of the General Government ought to be extended to the relief of individual suffering which is in no manner properly related to the public service or benefit. A prevalent tendency to disregard the limited mission of this power should, I think, be steadfastly resisted, to the end that the lesson should be constantly enforced that though the people support the Government the Government should not support the people.[38]

Citizens at the meeting who were not swept away by the idea of bug slaughter took exception to Riley's proposed approach. One of the original commissioners had written that the spraying his commission had done was "worse than ineffective, to the great expense of the state."[39] Mayors and selectmen had seen trees sprayed so many times that the caterpillars were glistening with arsenic without being affected in the least. But Riley refused to believe that spraying didn't work; he argued that failed sprayings were due to impure arsenic, disproportioned mixtures, or inexpert application. The citizens

present contended that combatting the moth by hand and destroying the eggs or capturing larvae under burlap bands had proved to be both highly effective and safe, but Riley was dismissive: "I remember distinctly a little cedar tree not more than six feet high in my own grounds that was attacked by the bagworm. I thought I would see whether I could not clear them off. I worked for two consecutive months picking off from the tree the issue of not more than two females. . . . Yet in the Smithsonian grounds I have absolutely stopped similar injury on larger trees in a few minutes by spraying."[40]

No one knows why Fernald, did not express any reservations about the failure of spraying and yielded the stage to Riley while the laymen in the room expressed their misgivings. Had Fernald confirmed that the spraying of gypsy moths had indeed been ineffective, Riley might have reconsidered. But Fernald placed absolute reliance on scientific experimentation—especially his own work at Amherst where he felt he had the finest laboratory in the country—and until controlled experiments proved that the gypsy moth could *not* be dealt with using arsenical spray, he would pay no attention to the anecdotal reports of common men.

Scudder alone among entomologists in the room remained unconvinced that the moth could be exterminated. He cautioned the group that if the insect could not be destroyed, it would have to be held in check indefinitely. And he was beginning to see the unfolding plan to concentrate on spraying for what it was—a high-profile campaign to demonstrate the killing power of economic entomology: "I don't understand the force of the arguments used by my neighbors on either side [Riley and Fernald] of delaying the work by not taking the eggs at present. Why do they want all the caterpillars out that they can get, in order to exterminate them?"[41]

When Riley began to explain arsenical pesticides and spray nozzles, Scudder excused himself from the meeting. The relationship between the two had cooled considerably during the 1870s when Scudder, a taxonomic "splitter," had proposed a great revision of the Lepidoptera, and Riley had been in the forefront of vociferous opposition. At about the same time, Riley was trying to regain the job of chief federal entomologist, but Scudder had taken a prominent role in supporting the incumbent, J. H. Comstock. Scudder was also instrumental in blocking Riley's membership in the National Academy of Science, which Riley never forgot.[42] Scudder was put off by Riley's "high and mighty" tone.[43] And he made no secret of believing Comstock to be a more effective chief entomologist.[44] The notion that all was not well between the two is reinforced by the dismissive comments Riley made after Scudder left the room: "I am so impatient of any efforts to simply check it. I have nothing to say about checking it; I speak for stamping it out. Mr. Scudder simply says he doesn't think it will be exterminated."[45]

Riley could not conceive that a spraying program would fail. He repeatedly urged the group to "show what you can do," and to "make the attempt" at extermination in order to avoid the disgrace of standing idle while a pest took over the country: "All other means are puerile as compared with destruction by the arsenicals. All other means are now abandoned in fighting the canker-worm, the coddling moth and some other insects, and intelligent spraying at the proper time has come to be looked upon as the most efficient means of protection against these insects."[46]

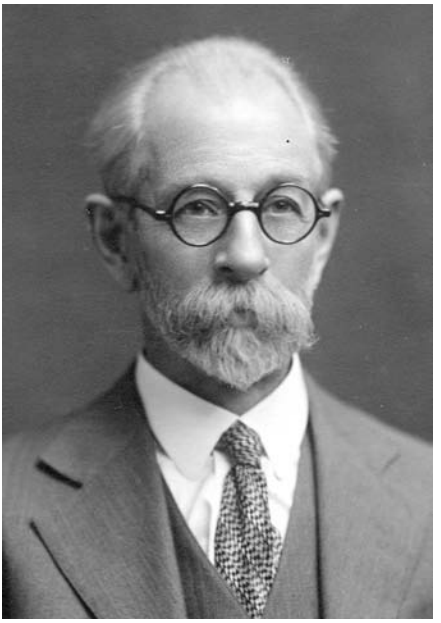
The meeting came to an end at six o'clock, by which time the small room, with its windows closed against the chilly March winds, was likely filled with smoke from all the oration and the liberal use of tobacco (a habit that seemed endemic to all Civil War veterans). The course of the war had been decided, but the solution to the problem had not. The opinions of citizens had been totally dismissed. Shaler and Sessions were unsure of their chances to eradicate the moth, but they had just taken decisive action at the highest levels of state power to bring gypsy moth work under the Board of Agriculture, and they could not very well go on record now as recommending that it was best to do nothing. Fernald had proposed extermination; the act passed by the state legislature mandated extermination; and the law limited the commissioners to extermination.

[CHAPTER 6]

The Moth Slayers

PRESENT AT THE MEETING of March 4 was Edward Howe Forbush of Worcester, director-designate of fieldwork at a salary of $50 per week. Forbush was born in 1858 in Quincy, Massachusetts, to Leander Pomeroy Forbush and Ruth H. Carr. A man of medium height and lithe, athletic build, he had prominent ears and nose, and a high forehead surmounting a face that reminds one of a scholarly owl, an impression reinforced by the large, round eyeglasses he wore later in life. It is an indication of the times that Forbush was largely self-educated, but unlike others of the era, he made a conscious decision to reject the educational opportunities available to him: "I determined to forgo a college training, to earn my own living, to be independent of all assistance, and to train myself by experience, observation and reading. So at the age of fifteen years I gave up school. My vocations for the next seven years were those of farmer, laborer, and mechanic; my avocation, the study of nature. Thus I grew up independent, self-supporting, developing body and mind, preparing myself for the work that I seemed best fitted to do."[1]

At the age of sixteen he was appointed curator at the Natural Museum of Ornithology in Worcester, Massachusetts, and later became president of the Worcester Summer School of Natural History. He taught himself to draw birds and illustrated his own books on ornithology. Forbush loved to hunt, and soon after dropping out of school he taught himself taxidermy; for some years he supported himself by operating a hunting and taxidermy business called the "Naturalists' Exchange" at 424 Main Street in Worcester. He advertised himself as a maker of "instruments and supplies for taxidermists, entomologists, oologists, botanists, and mineralogists, and a dealer in birds, mammals, skins, mounted specimens, bird's eggs, insects, shells, fossils and minerals."[2] On June 28, 1882, he married Etta L. Hill, and sometime afterward he sold his share of his taxidermy business—in which he had become partners with William S. Perry—to the naturalist and ornithologist Charles K. Reed and his son. When Forbush assumed his position as field director for



Edward Howe Forbush in midlife.
Special Media Services Division, National Archives & Records Administration.

gypsy moth work he was thirty-three years old with the first two of four young children to feed.

History does not tell much about Forbush in his earlier years. His intentions must be deduced from his actions, but in one matter there is no mystery: what he really wanted most of all was to be the state ornithologist of Massachusetts. Like most men in the natural sciences of his time, Forbush saw the direction being taken by state governments in making such areas "official" within their bureaucratic structure. Forbush was a dedicated, persistent—some might say stubborn and obsessive—man, and a good organizer. Henshaw remarked on Forbush's "tireless energy."[3] Something about him impressed the new gypsy moth commissioners, who wrote of their choice: "Mr. E. H. Forbush of Worcester was appointed director of the field work on March 12, 1891. . . . The commission was obliged to secure his release from an engagement for scientific work in order to obtain his services."[4]

Finding a qualified man to assume the duties of field director was not easy. There were no precedents for the work, so there was no pool of experienced applicants. According to some estimates, there were approximately eight hundred individuals in the United States engaged in some form of entomological work at the time.[5] But those who subscribed to the tenets of economic entomology numbered no more than two dozen, and none of them was available.

Fernald had again recommended Samuel Henshaw instead of Forbush for

director of fieldwork under the new commission, no doubt hoping, as he had hoped before, that having a qualified entomologist in charge would allow him to slip back into his professorial duties at Amherst. Henshaw, thirty-seven, was already known for his *List of the Coleoptera of America North of Mexico*, published in 1885. He was considered an economic entomologist because of his multipart work, *Bibliography of the More Important Contributions to American Economic Entomology*, the first three volumes of which were published by the U.S. Government Printing Office in April 1890.

Henshaw was a short, strong man whose reclusive nature has presented difficulties for historians. R. T. Jackson wrote that Henshaw's principal characteristics were his "sensitiveness, sense of fun, his personal integrity and his devotion to his work and friends."[6] Mary P. Winsor, on the other hand, has described him as a man who was "rigid, humorless, lacking in ideas, and antisocial."[7] Henshaw may have been obsessed with detail and blunt in speaking the truth, but his correspondence with Scudder, Fernald, Howard, and Riley show that he was both respected and highly trusted by his colleagues.

Commissioners Sessions, Appleton, and Shaler held two meetings with Henshaw, but their offer came at an awkward time because Henshaw had just accepted a promising position at the MCZ, assisting H. A. Hagen. He did seriously consider accepting the post of field director and even obtained a leave of absence for this purpose from his duties at the Boston Natural History Society.[8] But even though the wages offered by the commission tempted Henshaw, he was wary of promises that sounded too good to be true. Once he had seen what the job would entail and the pressures he would be under while directing this sort of work, he rejected the offer: "I looked over the matter and talked it over with [the commissioners] at two meetings, and then decided I would not have anything to do with it on the general ground . . . that it would be absolutely impossible to exterminate an insect of these habits, unless you are willing to go to the extent of making the region which it infests an absolute desert."[9]

The problems of finding an entomologist were so great that the commission had to consider those at work elsewhere in the field of natural sciences. Forbush's selection could not have been based on his credentials, because he had none. He was an adventuresome high school dropout who had been a taxidermist until a few years earlier and then a self-made naturalist in the business of getting himself sent on expeditions. He knew nothing about the gypsy moth, lacked formal training in the sciences, and had never been responsible for a large payroll or run a big organization with many employees.

The commissioners were in haste to find a field director, however, and could not be choosy. With less than three weeks from their inception on February 15 to the advisory meeting on March 4, they were anxious to make their

selection. The caterpillar hatch was only seven weeks off, and the commissioners wanted to have an administration organized by then that could place a force of men in the field. William Brewster, assistant in ornithology and mammalogy at the Museum of Comparative Zoology, knew Forbush as a skilled taxidermist who frequently prepared or mounted specimens for the museum, and it may have been through him that Forbush's name came to the attention of others. Forbush maintained that the offer of field director surprised him, that he had neither solicited the position nor even desired it.[10] He later testified:

> I received a communication from a friend in Cambridge early in 1891, saying that Frank Bolles, [Governor Russell's] brother-in-law, I think, who was then secretary of Harvard College, had recommended me for a place on this Gypsy Moth Commission. . . . The next time I came down [to Boston] I went into the State House and saw the Governor. . . . I told Gov. Russell then and there that I did not want my name mentioned in the matter in any way, I did not want to be considered and I should not take the place if it was offered to me. I supposed that settled it.[11]

Forbush had not yet experienced the persuasive skills of Nathaniel Shaler, whom he did not know, and he was surprised to receive a telegram from Shaler asking him to come at once to the board's rooms in Boston. Forbush, preparing to leave on an expedition, had just learned that he would be delayed for weeks by ice that blocked his route in the northern latitudes. With time on his hands and little money in his pockets, he decided that meeting with Shaler could do no harm.

History shows that Shaler not only feared the moth but was a compelling speaker, so doubtless he presented a moving argument why Forbush should help fend off the grave danger facing the Commonwealth. Forbush never had a chance; his self-educated mind and naturally formed independence were no match for Shaler's erudite supplications, and his horizons surely expanded during his talks with the dignified professor from Harvard. Before the two parted, Forbush agreed to help organize the field force for a period of six weeks while the northern ice melted and the commissioners searched for a permanent director. Had it only been so, he never would have lamented later: "I began to organize the force. I left my family. I never went home. I stayed right there, never saw home for a week, and got right in the field and organized a force. Then they sent off and got my contract annulled . . . and I have been here ever since."[12]

The day after his appointment, Forbush took a train for the three-hour trip

to Amherst. He went to the agricultural college and engaged nine students to use as his core of inspectors. Then he spent a few days discussing the gypsy moth with Fernald, who, averse to the idea of further entanglement with the work, likely saw in Forbush a bright and capable man whose lack of experience with insects was an asset. The new field director presented a clean slate on which the ideas of economic entomology could be written, and the work Fernald feared would fall on him could now be delegated to Forbush. He suggested to Forbush that entomology students from the agricultural college train the field force to watch for evidence of parasites throughout the long season of work and advised Forbush to experiment with native parasites to see if they could be used effectively against the gypsy moth. He did not want the state to incur the expense of importing European parasites if native parasites "might be able to render all the assistance that could be expected."[13]

The spraying devices being researched at Amherst—some were kept in storage there—were of great interest to Forbush, since most entomologists believed that intelligent and concentrated use of spraying devices would bring a quick end to the invaders. Before the two men parted, an informal relationship had worked itself out. Fernald would be the architect of the thrust against the insects, and Forbush would be the sword in his hand: "From that time Professor Fernald's advice and assistance were always freely sought by the committee and director [of fieldwork], and as freely given. All plans made were submitted to him for approval and were only perfected after a careful consideration of his recommendations."[14]

The outcome of the meeting surely pleased Fernald. The generous appropriation expected from the legislature, the capable men appointed to the new board of commissioners, and the application of scientific insect extermination principles reassured him that this time the job would be done right. Either the worst would be over in a few years, or Forbush would gain enough experience to carry matters forward on his own and let Fernald's life get back to normal. Forbush was still thinking of his "elaborate expedition" into the Newfoundland interior, an adventure now delayed so he could prepare an inept and ragtag army to fight an invading insect about which he still knew little.[15] The expedition was the "scientific engagement" from which the committee had secured his release. Forbush had been unsure about assuming the obligation, and some years later remarked to his friend and colleague, John B. May, that he had accepted only out of a "sense of civic duty."[16]

Forbush felt that his time with Fernald had been well spent, and the unlimited access he had been given to Fernald's tremendous store of knowledge was reassuring. He would have no time in the next six weeks to study the history of the gypsy moth in North America and its method of distribution. The administrative and physical details of forming an army would require enor-

mous amounts of his time, and he still saw his term of service extending only six weeks. Thanks to Fernald he would enjoy the services of knowledgeable young assistants while the commissioners planned the best course of action against the invaders, leaving him free to apply his efforts where they were needed most.

Groundwork

The new commissioners met with some of the former commissioners on March 12 at the agriculture offices in Boston and were given a map showing the expansion of the moth during the previous three years. This was the first time the new commissioners learned the probable extent of the moth's dispersal. Prior to 1888, the insect was thought to be concentrated only in the Glenwood section of Medford. In January 1890 the moth had been discovered in parts of four towns and the city of Malden; by January 1891 it could be found in varying densities in thirty communities, including the northern periphery of Boston. The commissioners accepted the map as reliable and called the line drawn around the infested area "the boundary of 1891." The boundary remained the farthest extent of the extermination effort that followed in succeeding years, and the area it enclosed was the focus of almost all the work during the life of the state commissions.

The Board of Agriculture held a meeting on Tuesday morning, April 28, at eleven o'clock in Boston's Commonwealth Building to discuss the gypsy moth and develop a program to carry out the mandates of the legislative act. The entomologists did not wait long to cash in on the state's largesse; there was an item on the agenda asking the legislature for even more money.[17] Thirty-two board members were present, as well as Charles Fernald and Edward Forbush. The act was read by Secretary Sessions; Shaler described the situation; and Fernald answered entomological questions. Forbush spoke about the costs of the proposed campaign, estimating that the following year at least $50,000 would be required. The commissioners held out hope that the moth had not made such a great expansion in such a short time but that the apparent increases discovered were the result of better reporting.

Operations of the interim commission were put into effect quickly. It reopened the office facilities and warehouse used by the first commission and took stock of the contents. It published a set of eleven rules and regulations

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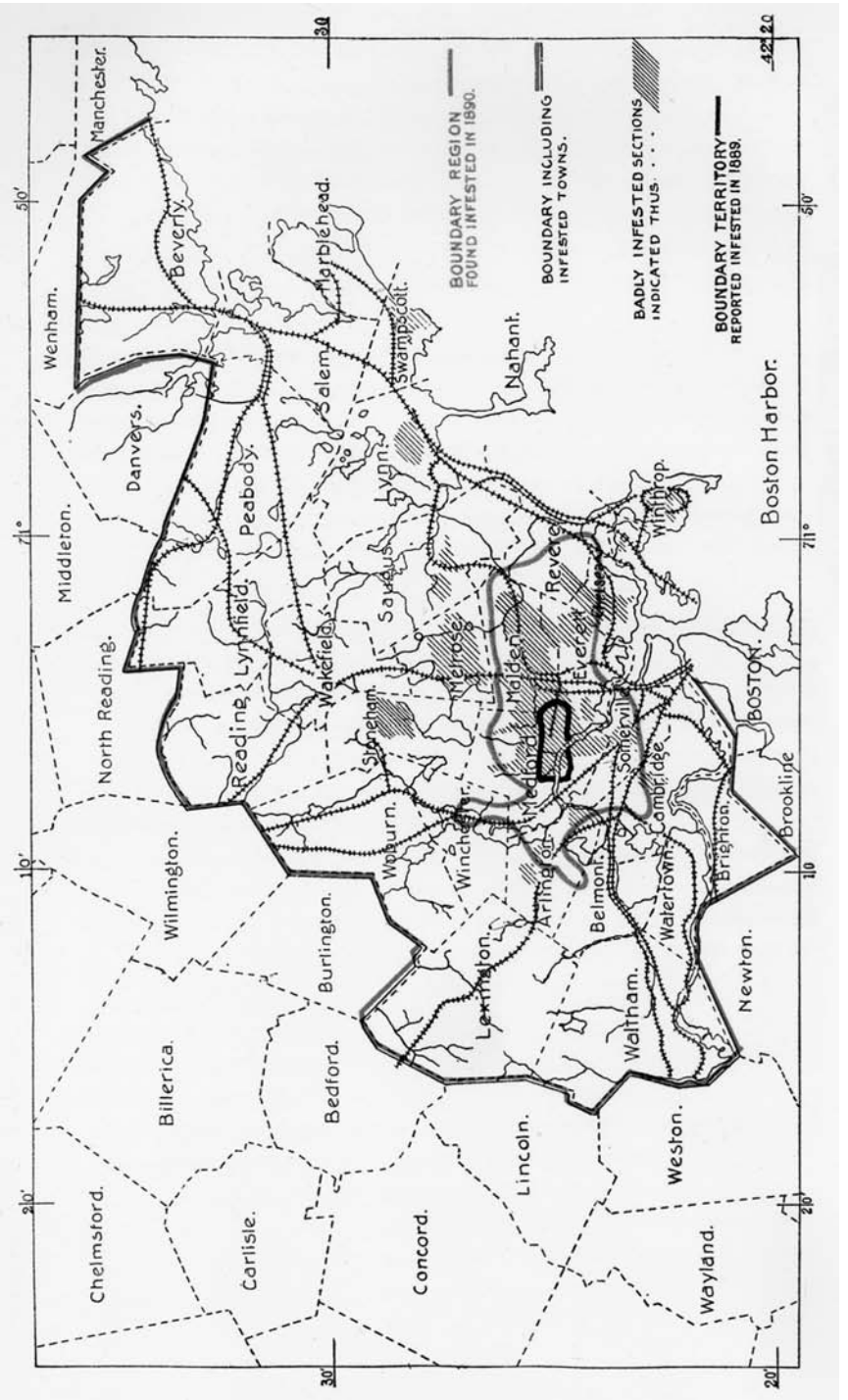
Map of 1891 showing the spread of the gypsy moth from its original point of infestation.
From *The Gypsy Moth.*


BOUNDARY REGION FOUND INFESTED IN 1890.
BOUNDARY INCLUDING INFESTED TOWNS.
BADLY INFESTED SECTIONS INDICATED THUS. . . .
BOUNDARY TERRITORY REPORTED INFESTED IN 1889.
Manchester.
Wenham.
Beverly.
Marblehead.
Middleton.
Danvers.
Peabody.
Salem.
Swampscott.
Nahant.
Lynn.
Lynnfield.
Saugus.
Winthrop.
Boston Harbor.
North Reading.
Reading.
Wakefield.
Melrose.
Malden.
Revere.
Everett.
Stoneham.
Medford.
Somerville.
BOSTON.
Wilmington.
Woburn.
Winchester.
Arlington.
Cambridge.
Brookline.
Billerica.
Burlington.
Belmont.
Watertown.
Brighton.
Lexington.
Waltham.
Newton.
Bedford.
Chelmsford.
Carlisle.
Concord.
Lincoln.
Weston.
Wayland.

for the general public and had them widely distributed. Citizens were forbidden to move any life form of the gypsy moth from one place to another. Residents and businessmen of Medford, Everett, Chelsea, Malden, Melrose, and Arlington were prohibited from driving wagons with hay, manure, wood, bark, trees, rags, lumber, or shrubbery without a written permit from the board and without covering their wagons with canvas tarpaulins. Teamsters were told to expect delays at checkpoints while their vehicles and cargoes were inspected.

Forbush was certainly mindful of the conditions that had doomed the first commission, for he took extraordinary steps to ensure that all actions of his administration would withstand any audit. Meticulous record keeping was instituted for everything done, from hours at work to numbers of individual insects destroyed. Items of equipment, such as axes, were obtained by purchase order. Each axe was stamped with a serial number before being issued, and each man was to use and be responsible for only the axe he was issued. A journal of the axe was kept and its condition noted each time it came in for a new handle or sharpening. No axe could be discarded until a committee member or his designee had examined it and signed a written document condemning it. Lists of condemned property were kept indefinitely. Records were kept in this manner for every piece of equipment in the committee's inventory from two-ton spraying wagons to pocket-sized inspection mirrors.

Forbush's Army I

Forbush complained for the duration of the campaign that he could never find enough qualified men to fill the positions available, even though the great waves of immigration that Massachusetts was still experiencing during the 1890s included a large percentage of able-bodied men between the ages of fifteen and forty-five.[18] But Forbush required that any man hired be able to speak and read English, which most of the immigrants could not, and every man was compelled to make a written application, tell about himself, give as many references as he could, and swear that he did not have a police record. There were tough vision standards, as well. Lists of acceptable applicants were kept, and men were hired in the order they applied. There was no age restriction, but any boy hired was expected to do a man's work. No inquiries were made into the applicant's religion, politics, or associations outside of work.

At the lowest level of Forbush's hierarchy were the laborers who did most of the actual work of scraping trees, collecting egg masses, killing larvae, and operating spray apparatus. Although the wages of a gypsy moth fieldworker

were considered good, his life was not pleasant, since it required subservience to quasi-military authorities of questionable competence, subjection to the harshest weather, and submission to long, grinding hours of service. There were no benefits. Incapacitated workers were dismissed and replaced by others, although if a man had training, experience, and a good record, he would likely be hired back once he regained his health. One visitor noted "the pains taken in examining the men for field work and the almost military exactness required of them in their labor."[19]

A training course of a few weeks was mandatory for all employees. Workers tolerated their schooling with varying amounts of grace but among themselves referred to Forbush's educational efforts as "caterpillar kindergarten." A workman's wages started at $1.50 per day, and after three weeks of satisfactory service basic pay was increased by fifty cents. Discipline was as strict as the men would tolerate. No smoking, drinking, or profane language was allowed while on duty. Five minutes' loafing on the job was punished by forfeit of an hour's wages. Fieldworkers were issued police-style caps and numbered blue badges; failure to wear the cap and badge while on duty caused immediate dismissal, and a lost badge cost a full week's pay. Each day's work began and ended with a military-style formation and calling of the roll. The men addressed their superiors as "sir."[20]

No laborer was assigned to work in the town where he lived, so all workmen had to incur additional time and expense for commuting. Regardless of the distance they traveled, inspectors called the roll at seven o'clock each morning. The length of the workday was nine hours at the designated location, not including the time taken for morning and evening roll calls, equipment maintenance, meals, and other duties and obligations. These requirements made the actual workday twelve or more hours for some men, in particular the "special police" assigned to inspect wagons leaving the infested district. Sixty-hour weeks were not only common but expected. The *Rules and Regulations for Agents and Employees of the Commonwealth* listed the roll call time at the conclusion of work not as a specific hour but as "night."[21] Despite the long hours of summer daylight, men reported leaving for work and returning home in the dark.

Above the "privates" in this army were the inspectors, who wore red badges and whose jackets and pants were a light blue similar to the uniforms of postal workers. An inspector was responsible for a squad of four to six men, commonly called a "gang." Inspectors were required to carry "section books" of one hundred pages in which they kept meticulous records of the fieldwork: the number of trees, buildings, fences, walls, hedges, and other objects inspected daily; the number of each on which a moth was found; the

number of each form of the moth found and destroyed by hand on each estate; the number of trees cut or treated by banding, burlapping, cementing, or scraping; and the number of acres of brush or woodland burned over.[22]

Inspectors warned passersby of spraying, ensured that windows of nearby houses were closed, prevented spraying crews from getting drift on themselves, and ascertained that only marked trees were treated. The inspectors were also charged with reporting any damages caused by the workers, the particulars of accidents on the job, and "the language and means used by persons obstructing their work."[23] They also kept time records of their men and did their best to sort out the "new and contradictory orders [that were] issued every other day or so."[24] Only inspectors were allowed to mix batches of poison in the field or to draw water for the tanks from standpipes.

Next higher in rank were the special inspectors, garbed in dark police blue topped with a white cap. Later, six superintendents were added to ease the demand for Forbush's personal supervision of large areas, and later still the superintendents were provided with assistants. (The "supers" were kidded that the dainty white fringes on their badges were appropriate for men who did not have to get dirty doing real work.) At the top of the army was Field Director Forbush, who wore civilian clothes and visited the combat zones in a private carriage pulled by a fast horse. An ever increasing staff at the office and the storehouse supported fieldworkers, sometimes numbering as high as thirty employees. These included Forbush's personal secretary, clerks, typists, stenographers, cartographers, janitors, quartermaster, machinists, mechanics, and a chemist.

Also included in the army was a small, clandestine group of men called "spotters," who were paid to spy on the others, moving constantly from place to place, observing from secret locations, and reporting any rule violations back to Forbush; they traveled by horse and bicycle, and were despised by the regulars. Further, at Fernald's request and in keeping with the notion that the gypsy moth campaign would be a test bed for economic entomology, a small "experimental force" was created (later renamed the "scientific corps"), which consisted mostly of college men whose work in the field would be along different lines than that of the average laborer. As the field force became known as the "gypsy moth army," one of the original members of the experimental force wrote to his college newspaper: "The word 'army' was applied first, I think, by the newspaper men, and as if to further carry out the ideas the writer at one time received an order from the Director to allow Mr. ——— to report to the office at noon 'as he had been detailed for duty in the experimental squad.' Quite military, was it not?"[25]

First Forays

By March 19 the nucleus of the field force for the summer of 1891 began to form when nine students from the agricultural college were released from their classes and reported to the agriculture offices in Boston. There they received instructions and were dispatched to Malden. They were joined the next day by fewer than a dozen men who had worked under Rawson. Forbush had culled most of Rawson's roster by laying out stringent standards, hiring only those he felt were fitted by both nature and training for the work that lay ahead. The experienced men had done little more than burn egg masses off the trees, while Forbush and the college boys had no experience at all. They would have to learn how to recognize the eggs of the gypsy moth and distinguish them from the eggs of native moths, how to recognize larvae and pupae, and then how to teach all of what they had learned to new employees. So little was known about the moth or its habits that any man with experience in the natural sciences was delegated to observe the habits of the enemy and report back to headquarters all he had learned.

The force numbered sixteen men when work began on March 20. Forbush took them all to the Gilman Osgood farm in Belmont to make their first attempt at eradicating the gypsy moth; he selected the Osgood farm because the infestation there was reported to be small and isolated. It was perhaps predictive that an unpleasant surprise awaited them: the colony turned out to be neither as small nor as isolated as they thought. The recruits destroyed egg masses during the morning but stopped later in the day to make their initial attempt at scouting, which provided another vexing discovery: even their inexpert inspection revealed many other colonies thriving in the area.

The college men went on to work in the experimental corps, while most of the men who had worked under the first commission were given the rank of inspector and sent to scout the extent of the infested region.[26] Scouting continued in a cursory fashion during the spring with the idea of finding all existing gypsy moth footholds in the territory and making maps that would enable the field superintendents to demarcate their areas of responsibility. J. O. Goodwin of Medford, a civil engineer, did the mapping. While this task was in progress, Forbush continued increasing the field force whenever he could find the right men to hire. As new squads of men were formed, they were assigned to an inspector and sent into the worst areas of Medford and Malden to pick egg clusters and discover how the clusters were hidden.

More scouting was undertaken, beginning in Medford and working through forty-two cities and towns. The colonies and locations of the moth increased on a weekly basis, and the number of men hired soon rose to over one hundred. By the end of May the tally of infested towns had reached fifteen.

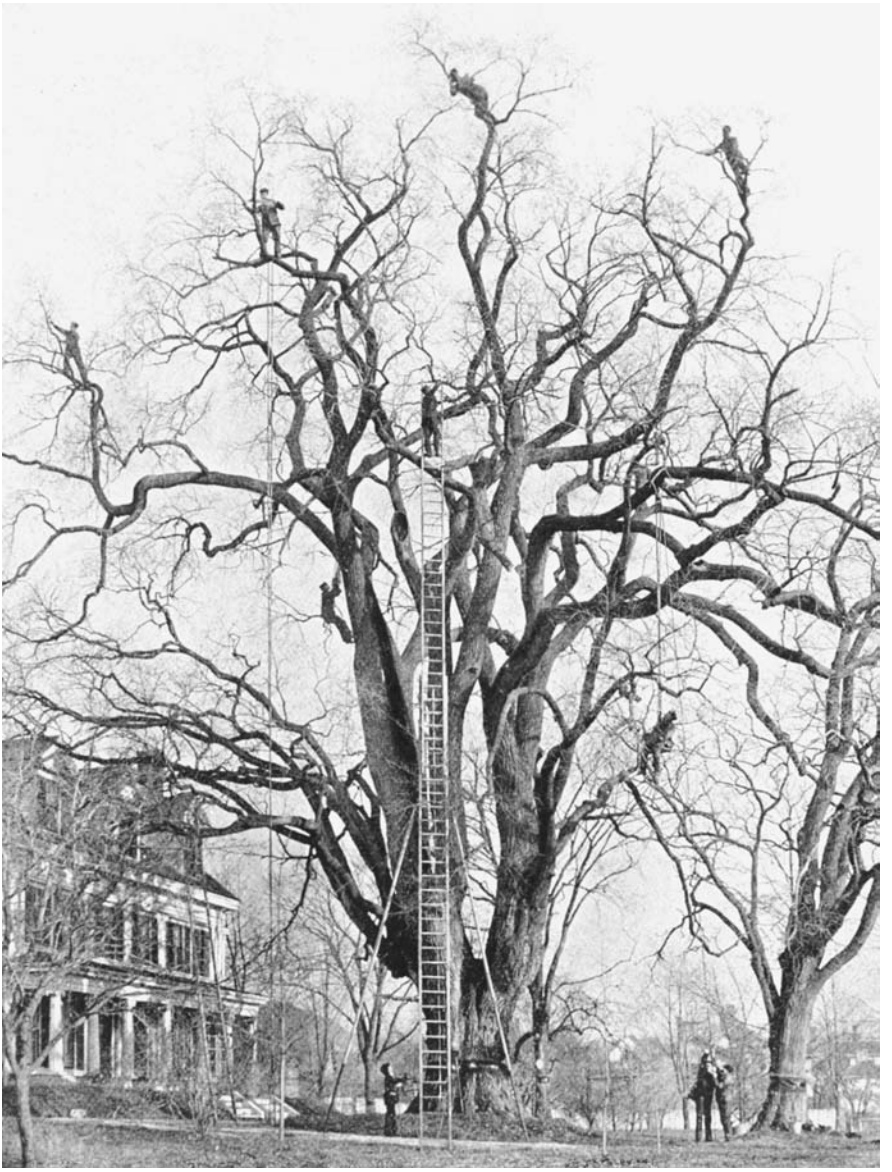
Substantial new colonies were found in Lexington and Melrose. Thirty townships were infested, including Revere, Saugus, Wakefield, and Winchester. Forbush pulled his recruits out of Medford and Malden and sent them to the infested regions of the outlying towns. The only good news was that for the moment, colonies in the woodlands were few in number, small in size, and widely scattered.[27]

The Dexter Elm and Other Revelations

The commissioners visited the infested communities to talk with citizens and found them nearly unanimous in their opposition to Riley's all-out spraying assault. Most believed that spraying gypsy moth larvae would not work and that destroying egg masses was the quickest, safest, and most effective way to combat the insect.[28] The towering elm trees lining many of the streets, however, posed a severe test for either spraying or handpicking. The greatest of these was the two-hundred-year-old elm on the Dexter estate in Malden, a magnificent specimen 110 feet tall with a circumference of 29 feet at the base and a leafy crown 104 feet in diameter. During the previous outbreak unchecked numbers of swarming gypsy moth larvae had completely defoliated trees of nearly this size in less than three days.

The workers were daunted by the request that Forbush made of them. Forbush said later that he had also harbored doubts about clearing such a large tree but did not let on to his men. The plan elicited much laughter from the citizens, who told Forbush he would need a balloon to get his men to the top of the tree.[29] Forbush selected four of his most experienced workers and sent them into the elm to rid it of egg masses. They used a sixty-five-foot fireman's extension ladder as a means of gaining access to the mighty elm, a ladder so heavy it required six men with block and tackle to deploy it.

Working without safety nets, the men scraped egg masses from the trunk to the very top of the tree, risking their lives by inching out as far as they dared on the slender young branches in the crown. In the most famous photo taken during the gypsy moth campaign, the daredevils in the tallest branches seem to disappear into the massiveness of the tree. The first crew removed thousands of egg clusters over a period of four days before announcing that the tree had been cleared. The following morning Forbush sent a second group of workers into the same tree, and before they were through they found another six hundred egg masses. Forbush learned that the eggs were not easy to find despite being hidden in plain view, that even experienced men working close to known egg mass concentrations could overlook them by the hundreds, and that there was value in using fresh crews to examine areas



The Dexter Elm on the Dexter estate in Malden.
Posed photo probably taken in 1894 or 1895.
From *The Gypsy Moth.*

previously worked over. A final lesson was learned when egg clusters that both crews had missed hatched at the start of the caterpillar season.

Pondering Parasites, Probating Pesticides

Fernald continued to vacillate on the subject of parasites and predators, his instincts as a scientist conflicting with the demands of economic entomology. He had not rejected the systematic approach to investigating insects and believed that he should be free to work in whichever mode seemed to him appropriate for the situation. These opposing pressures led him to investigate parasitic insects and establish insectaries at Amherst and Malden while maintaining an official stance in opposition to the idea. The gypsy moth commission held meetings on the subject and, urged on by Nathaniel Shaler, began to push Fernald to explore the possibility of importing parasites and other natural enemies of the gypsy moth. The commissioners' recommendations were sent up to Secretary Sessions, who then passed them on to Fernald, as in this example written on March 17: "What Prof. Shaler suggests is that you open a correspondence with men you knew in Europe in regard to the importation of parasites of the G. M. . . . Shaler thinks they could be procured by you through your professional connections. . . . I understand the idea to be to open a correspondence as preliminary to sending the parasites when we want them if we want them."[30] Fernald had already been through the drill often enough to know the Europeans were likely to lack enthusiasm for the idea. Moreover, but the project bogged down when Shaler received notice that his mother was dying and departed Cambridge for his family home in Kentucky.

In April the commission's headquarters was moved from Medford to Malden, where better facilities were available and rail links were more numerous. The Malden building on Commercial Street was an old livery stable built on piles six feet above swampland on every side except the street, and everyone who worked in it disliked the structure. Fernald and his assistants prepared a room in which they began experiments with arsenical insecticides. So many subject and control caterpillars died that the professor could not tell if the deaths were due to the insecticides or to the unhealthful surroundings. The test results were thus thrown into question. The testing indicated, however, that Paris green was still the insecticide of choice, though at that time there were not many others to try. Paris green was a formula of 40 percent copper and 60 percent arsenic that burned foliage at strengths as low as four ounces in fifty gallons of water. London purple, an alternative arsenical, burned the foliage even worse, and contact insecticides such as whale oil and kerosene-emulsion types were unsuited for general-purpose spraying. Given the results

of these experiments, then, the committee ordered more than a ton of Paris green for use during the summer.

On April 28 the Board of Agriculture met and officially chose Sessions, Shaler, and Appleton as "a committee with full powers to exercise all the duties and powers conferred by . . . House Bill No. 228."[31] The interim commission was dissolved and replaced by a committee consisting of the same three men. Sessions was appointed both secretary and chairman. Between the funds remaining from the previous commission and an appropriation of $50,000 on June 3, 1891, the committee had roughly $74,000 available for fieldwork.

Discouraging Citizens

Fifty thousand copies of the law of 1891 were printed and distributed wherever the moth was found. A bulletin of information and a colored plate of the moth were created, and thousands of copies were distributed throughout the state. One hundred and fifty specimen cases containing mountings of the moth in various stages of its life cycle were prepared and set up for exhibition in post offices and other public places within the infested territory.

Citizens were instructed not to remove or alter special marks placed on trees, fences, or buildings by fieldworkers. They were also told not to scrape or remove egg masses unless supervised by a fieldworker but were encouraged to burn all scraps and rubbish on their property. Destructive searches that resulted in damage to walls, fences, and other property would be repaired, or the owner could make the repair himself and request reimbursement. Residents were encouraged to screen their windows and to call in their dogs when state agents entered their premises.

The purpose of the rules was to eliminate the public from any but the most trivial aspects of the work. In this regard the gypsy moth leaders were of one mind. Remembering the events of the previous year, they considered that citizen apathy and opposition had been more detrimental to the work than the bungling efforts of an inexperienced commission. They thought the idea that citizens could provide any effective pressure against such a widely distributed insect was absurd. The economic entomologists wished to eliminate all disruptive influences on their experiment and viewed the citizens of the Commonwealth as incapable of doing such work themselves or understanding the work when others did it. The committee and its field director did not even take into account the fiercely independent streak of farmers and fruit growers in the Bay State who were opposed not so much to controlling the moth as to letting the state's minions trespass on their land.

The reasons against enlisting schoolboys to collect eggs, as expressed by some of the most intelligent men of the time, present a glimpse into the mindset of the era. The committee members were convinced that young boys would regard the undertaking from an economic viewpoint and set up seasonal businesses collecting eggs for profit. They would thus defeat the process by not reporting every location or not collecting all the egg masses they found but leaving large areas of infestation unmolested in order to guarantee a bountiful supply of egg masses the following year. When this contention was first expressed at the meeting of March 4, 1891, everyone in the room found the argument so convincing that not a single person spoke out against it.

[CHAPTER 7]

Summer 1891

When J. O. Goodwin's mapping was finished, the infested region was divided into sections, and each was assigned to a foreman or an inspector. Additional men were hired and trained, a process that continued all summer until the field force numbered 242. The committee inspected residential areas treated by the first commission to determine whether earlier work had been effective. Workmen dismantled fences, pulled up wooden boardwalks, tore apart the steps of houses, and entered buildings, actions that at first astonished the public. Although few egg masses were found on trees, some cellars were badly infested, and quarts of eggs were removed. Ripping apart steps and piazzas yielded bumper crops of egg masses while creating a reservoir of ill will among the populace.

Section eight of Medford, which included the house at 27 Myrtle Street where Trouvelot had pursued his will-o'-the-wisp thirty years earlier, now contained houses, shops, and factories. In 1886 the Andersen Pressed Brick Company constructed a facility on land that included a portion of Trouvelot's back yard. The streets leading into the city center featured gardens and orchards on both sides, and three thousand heavily wooded acres in the Middlesex Fells lay just a quarter-mile away. As the committee glumly noted, "Here we have all the requisites for the sustenance of the insect and all facilities for its transport in all directions."[1]

The first commission had treated section eight extensively, but agents who entered the district in March 1891 were alarmed by the conditions they found. The brush and woodland contained so many egg masses that they could not have been destroyed by hand even if all the men available had been put to work. Female moths had been present in such great numbers at egg laying that thousands had deposited their eggs on the ground in plain sight. Others had crawled into an old stone wall and covered it with egg clusters. Workers tore down the wall and inspected every rock. The number of larvae calculated to hatch from just this one wall ran into the millions, which Forbush said would have "let loose a destroying host upon the entire neighborhood."[2]

Cleaning the yard of the Andersen Pressed Brick Company disheartened the workers, for the entire premises were infested. The men inspected 232,195 individual bricks (some of which were completely covered with egg masses), scraped them clean, and burned the eggs on the spot. Workers ripped up floorboards of sheds in the yard to get at the egg masses underneath, repeated the procedure on the wallboards, then tore out everything under the roof. The destructive search for egg masses weakened some sheds to the point of collapse; these structures were pushed over and burned. A guard was posted at the gate, and every brick shipped out was inspected. Workers sent to clear the Muller Brothers Tannery in North Cambridge burned 30,000 egg clusters, but in most other places egg clusters were so numerous that no attempt was made to count them.

The egg masses destroyed in the first six weeks of work filled eight horse-drawn carts and prevented the hatch of 400 million caterpillars. This number included only clusters destroyed by hand; no records were kept for those destroyed by other means. Field equipment was expanded to include small, specially made oil stoves in which eggs were burned. In an effort to destroy egg masses on the ground, the leaves and underbrush were saturated with crude petroleum oil and set ablaze. This process was not effective because much of the oil soaked into the ground before it could be ignited, and the blaze was too weak to consume the eggs. In experiments with the air-pumped naphtha burners used by painters and plumbers to produce a hot flame, egg masses on trees and rocks could be incinerated, causing the eggs inside to burst like corn in a popper.

Meanwhile, the ice melted in the northern latitudes, but the Newfoundland trekkers departed without Forbush. The never-would-be leader of that expedition found himself in command of a much more imposing organization and in possession of far more power and authority than he had ever experienced before. Hundreds of men awaited his orders, and he insisted that they do a thorough job, adhere to the high standards he set, and work over the same ground again and again until it was swept clean of the insect.

Joined in Battle

By the middle of April the gypsy larvae began hatching and feeding. This was the moment the economic entomologists had been waiting for: the mighty blow that would knock the invaders down by the millions and clear the infested area within a single season was about to be struck. There was no lack of opportunity for engagement. Near McGowan's Tannery in Medford, larvae gushed from between the walls of the tannery building and were collected by the pailful.[3] One resident of Medford estimated that he saw a million

A typical "heavyweight" sprayer in the field, circa 1891.
From *The Gypsy Moth.*

caterpillars just at the intersection of Fountain and Salem Streets. Because Forbush had abandoned work in the center districts, the hatch in Medford and Malden was unhindered, and larvae were exceptionally numerous there. Saugus too experienced heavy infestations, with residents reporting that they could hardly go out the doors of their houses.[4]

Misfortune and confusion occurred at once. The abnormal and extended hatch of the larvae that began in mid-April did not conclude until June 17. By July 10 the moth could be found everywhere in all its forms; scouts even reported the presence of newly laid egg clusters.[5] Since Forbush barely had plans in place for fighting the moth in its successive individual stages, neither he nor the committee knew what to do when confronted by all the stages at once, and Fernald, too, was confounded. With the state's foot soldiers engaged completely, Forbush ordered his mechanized units into the field. More than thirty teams and some 230 men were employed to carry the spraying forward: "When the caterpillars appeared, spraying was commenced with a large force of men and teams equipped with hogsheads of paris green and water, pumps, hose, ladders, oil suits, etc.—an extensive and expensive outfit."[6]

Twenty heavyweight rigs were sent into Medford, and the rest were deployed on the periphery of the infested area. The driver and a helper alternated

stints at the pump while standing on a plank that was supported at one end by the top of the pesticide tank and at the other by a special brace raised on poles above the teamster's seat. The pump required a strong and continuous effort to maintain pressure. The discomfort of the workers was increased by the requirement that they work in the warm days of late spring wearing their uniform jackets.

The spray crews were instructed to work toward the center of the infested region, slaughtering the gypsy armies as they went. The rigs were designed for use on smaller trees in orchard rows, consequently they were fitted with short hoses and lacked throw. If the trees to be sprayed were tall, the spray men mounted stepladders to gain a few extra feet of height. For very tall trees the nozzle man was instructed to climb the tree, followed by helpers bearing the heavy hoses, and to spray from below as they ascended. All the spraying crews were subjected to large amounts of drifting and dripping pesticides.

Wagon checks were tried again after the larvae emerged. Shaler, Forbush, and several inspectors supervised the work of the police personally, but the examination of individual carts and wagons was abandoned after two weeks by vote of the committee when it became obvious that the manpower, time, and energy could be better utilized elsewhere. Forbush regarded wagon checks as so ineffective that he once said he believed "if a man had an edict published against carrying yellow dogs out of the infested regions they might be carried out in a carriage and be missed by such an inspection."[7]

A small number of men sent to check reports of moth activity found roadside infestations in six more towns, areas which, added to those already known, proved too large for the force. Once again Forbush abandoned work in Malden and Medford and sent detachments to the outlying areas. As state crews abandoned the center, local governments were forced to take over the work there, tending and replenishing the tarred paper strips put on their trees for cankerworms and gypsy moths the year before. Disgusted residents ignored the committee's edict not to work and resumed battling the hordes of larvae. The hatch was largest in Medford and Malden, and local crews visited the trees repeatedly to refresh the sticky barriers, using their heavy brushes to apply new printer's ink and crush the caterpillars under the bands. Forbush, impressed by how much protection the bands provided, admitted that the banding work alone averted the much-feared total defoliation of all the trees in these two communities.

To the consternation and dismay of all, however, it became evident that Paris green did not work well on gypsy caterpillars. The crews spraying on the periphery suffered failures and, after advancing inward for several days without effect, retreated to the periphery for second and third sweeps. As a consequence of spraying these infested areas more than once, half of the

communities scheduled for spraying were not reached during the summer. If Fernald and the economic entomologists were surprised by these events, the populace was not. Citizens had warned the committee not to expect good results from spraying, and the summer's events proved them right. The remarks of citizens also had their effect on the moth gangs and even on some of the young entomologists, such as Dexter M. Rogers, working in the field for the first time. Rogers was not impressed with modern technology and chemicals: "During 1891 we sprayed almost continuously while the larvae were in existence. I made up my mind that spraying was useless with extermination in view. . . . The only way—and I have advocated it to our director and to the employees—is to get down and dig for them. Those we cut in two we know have been killed. When we treat an egg cluster we know it is killed. Science is a nice thing, but thorough work is better. Eternal vigilance is the only thing that will get the last one."[8]

Work was further slowed by unreliable equipment, and frequent breakdowns required that the apparatus be disassembled and cleaned barehanded by workers in the field. Cracks appeared so frequently in metal pump flanges and fittings that Forbush ordered the storehouse to be kept fully stocked with complete sets of replacement parts. The insecticides corroded the hoses within a few days, requiring maintenance that took the sprayers out of service. Pumps with leather valves were especially trouble-prone, and the metallic filters on the suction line corroded after just a few days' use. Forbush stipulated that each nozzle on each wagon be flushed twice a day by turning it toward the bottom of the tank and pumping at maximum pressure for five full minutes.[9] Piston pumps had no sealing rings, and messy packing made of hemp or cotton wicking saturated with oil, tallow, and black graphite had to be manually wound around the piston and secured with a packing nut before the pump would work.

The state recalled its thirty rigs and upgraded them to double their spraying capacity. They were sent back into the field, only to become stuck in rough woodland terrain again. The heavy wagons were once more withdrawn from the brush and set to work on the streets. Crews were ordered to spray all living vegetation within two hundred feet of any plant on which a caterpillar was found. Since nearly all vegetation hosted larvae, this order resulted in the spraying of just about everything, as Scudder had predicted. Citizens were alarmed to see their homes, yards, and gardens drenched with arsenic when there was no sign of caterpillars.

Twelve lightweight spraying units utilizing fifteen-gallon tanks were dispatched to outlying areas. These tanks could be removed from their horse carts and carried across rough terrain by a crew of two. The units were filled from hydrants where available, or their tanks replenished with water pumped

from wells or streams. Medium sprayers equipped with tanks of 100 gallons or less required a crew of three; the heavyweight sprayers with 160-gallon tanks were assigned a crew of five: two men were needed to operate the pump, two to spray, and an inspector to direct the operation. The teamster became the sixth crewman when spraying. His job was to agitate the insoluble arsenic mixture by means of a special paddle built into the tank.

Inspectors ensured that the men wore their badges at all times while spraying and enforced the no-smoking rule during working hours. They also tried to prevent the hose from kinking and the spray from dripping on the workmen's clothing—the latter an impossible task. A fifty-foot section of heavy rubber hose was the most that one man could carry. Each wagon was equipped with eight lengths, but two lines of two hundred feet were employed for most operations. A toolbox containing wrenches, packing materials, and other tools needed to disassemble a pump was sent into the field with every wagon. Forbush prized men who could strip a pump and repair it, and it irked him no end when tardy budget appropriations cost him the services of his skilled mechanics. Without field repair, a sprayer had to be sent to the shop for work that could keep it there for several days of an already short spraying season.

Operating the pump exhausted the men. In the hot days leading into summer, fatigue became a constant factor, and one of the main complaints about the double-acting pumps was that the men often had to stop and rest. E. G. Lodeman called the labor of maintaining line pressure with a hand-operated pump "severe."[10] One student from the Massachusetts Agricultural College wrote for his college magazine:

> The work we are at now is spraying trees with paris green. Each inspector has a barrel mounted on a one-horse cart of some kind. To the barrel which holds about one hundred gallons of water is attached a pump and four hundred feet of hose in two lines of varying lengths. To work this we have four men and the driver. Carrying the hose up the trees is the hardest part of the men's work in spraying. But working the pump is no snap . . . (the job) takes all our time, leaving us so tired at night that we cannot study or do much of anything else.[11]

Popular opposition to spraying led to mass meetings in Medford, although little of consequence resulted. Citizens who wanted no arsenic on their property often turned their garden hoses on freshly sprayed fruit and ornamental trees. Some landowners were arrested for preventing moth exterminators from entering their lands, and one citizen who tried to cut a hose on a spraying tank was hauled before a magistrate. Henshaw noted that the fumbling attempts of

the field force "increased an already existing strong feeling against the use of Paris green, and many landowners did all in their power to annul or neutralize the work."[12] This aspect troubled the college men, who noted that "although we have many amusing experiences with people, it is not exactly a pleasure to invade a man's premises against his will, and know that he would kick you out if he was able."[13]

The citizens did support banding and burlapping trees, or picking larvae and scraping egg masses by hand. But they would endure the caterpillar swarms, tolerate the disgusting odors, and suffer the consequences to their trees and gardens rather than have arsenic sprayed in their yards, on their houses, and over their vegetables and fruits, and they did not believe the entomologists such as "Professor" Riley who tried to convince them the practice was safe.[14]

Riley's Return

During the spray effort, Riley returned to Massachusetts and went into the field with Henshaw to advise the crews, but the techniques of spraying were immaterial because the pesticides didn't work. Riley, who could not believe that arsenical poisons were not effective, fell back on the usual arguments about incompetent applications and applicators. He remained convinced that any delinquencies were the fault of the people rather than of the plan. Disturbed by the complete failure of his single-spraying strategy, he could not understand the refusal of the gypsy moth larvae to die when poisoned with the purest, finest, bolted arsenic applied in the most intelligent fashion.

Riley had chosen wisely when he engaged Henshaw to be his agent in Massachusetts. Both men knew how to cut to the quick, and neither was hesitant to express his views. As if to compensate for his lack of social graces and his short stature, nature had provided Henshaw with remarkable eyes and a mind that was equally sharp in seeing the point in a situation. Riley was especially interested in biological observations of the larvae and charged Henshaw with the task of noting any behavior of the gypsy moth in America that differed from its behavior in Europe.[15] Henshaw was astonished to find that in some places parasitic insects were present in great numbers, and he was appalled when the executors of the war not only failed to use the parasites to their advantage, but also destroyed them: "I saw in Medford a district where a parasitic fly was fairly swarming, and shortly after that the woods and brush were cut down and burned without any intimation of one of the best causes of the extermination of the insect being used."[16]

Nevertheless, the more Riley looked at the operation the more distressed he became and the more he blamed the committee for not devoting enough

time to the undertaking. He claimed that the treatment of trees had been rushed and the spraying had been uneven, and he was appalled to find that wagon crews were using nozzles intended for ordinary garden hose.[17] Although the spraying had nearly eliminated canker worms and tussock moth larvae, it had not delivered much of a blow against the gypsy moth. Riley complained long and loud to anyone who would listen and managed to offend almost everyone on the project:

> The members of the committee having the matter in charge were unable to give much personal attention to the work, and the spraying was being performed in a crude and unsatisfactory manner and without entomological supervision of an advisory character. No well directed and carefully conducted experiments had been made to ascertain what special methods are best for this particular case. . . . [I]n no instance, where trees were examined that had been treated, was it difficult to find living caterpillars on them.[18]

Riley later wrote to Henshaw that he felt "a good deal discouraged and disappointed" in what he had seen but wished to refrain for the time being from further public comment on the "blunders made and the want of intelligent guidance." He complained to Henshaw that so much valuable time had been squandered he could no longer see the value in helping the committee in any official capacity, after which he sent a shipment of a dozen cyclone nozzles to Sessions.[19]

Riley published the stenographic report of the March 4 meeting in *Insect Life*, and the distribution of this transcript annoyed Shaler greatly. He felt that exposing the discussion to the public was a reckless act, even though Riley had first offered the transcript to all present for their comments and revisions. Shaler was further insulted by Riley's assertions that the commissioners were slackers and later said that he had lost all confidence in Riley's judgment. Henshaw's report, delivered to Riley on December 7, 1891, and published by the federal agricultural department early in 1892, supported Riley's contentions. While noting that the committee members had given more time to the work than could have been reasonably expected, Henshaw said that "it was undoubtedly a mistake to appoint men to look after such important work . . . who were already more than occupied with other work. The fact that they were appointed with the distinct understanding that their services should be given gratuitously, while not equivalent to saying that their services would be slight, does indicate that they would be secondary to more important affairs."[20]

Riley did not endear himself to Sessions when he made it plain that the

extermination program was going to collapse unless changes were made at once. Sessions did not want to hear even a whisper that he should reorganize a committee that had just been reorganized two months before. Riley pressured Sessions to appoint Fernald as advising entomologist even though Fernald, who still had no official relationship to the board, had already begun the experiments Riley claimed were lacking, and Forbush had gone to great lengths to assign only his best men to the spray wagons.[21] Riley did not understand that the gypsy moths' ability to tolerate arsenic bordered on the supernatural. The pesticides had failed so utterly that workers were compelled to switch to crude contact insecticides after the fourth molt (when the insect sheds its skin). These formulations were a mixture of fish oil or whale oil soap diluted in boiling water and were used only when caterpillars could be drenched in large numbers.

After failing to persuade anyone in authority, Riley concluded that extermination would have to be abandoned. He continued to urge the Massachusetts men to reconsider their approach but found that he was largely disputing himself. His original arguments against anything except extermination by spraying had cost many valuable months, and it was likely now too late to make up lost time. Shaler, Sessions, and some other members of the committee had come to consider Riley a liability. Where they had once eagerly solicited his opinions, they now felt constrained to keep him at arm's length. For his part, Riley was "quite surprised that the committee is so unwilling to take my advice, although they are quite willing to express their thanks."[22] Later, he said that the condition of the campaign had been so disturbing to him that he was unable to discuss it without finding fault.[23] Returning to Washington, he recorded his visit to Massachusetts in the next issue of *Insect Life*, admitting that "as the possibility of extermination becomes doubtful, all effort looking to the control of the species as one to be continually dealt with grows in importance, and it is strongly recommended that an effort be made to introduce some of the natural enemies of the species which are known to occur in Europe."[24]

Thereafter, spray wagons surrendered their place of prominence to hundreds of foot soldiers bearing rolls of burlap. The simple technique of wrapping tree trunks with bands of cloth impressed everyone with its effectiveness and became the main method by which the larvae were combatted for the remainder of that season. Over 68,000 burlap bands were deployed during the summer, trapping millions of caterpillars. Forbush noted in his report for 1891 that one gang of three men who did nothing but visit burlap bands killed almost 120,000 caterpillars and pupae in just two days.[25]

Fernald had resisted pressure to formalize his relationship with the gypsy moth committee, and at the height of the summer's battles he made one more

attempt to have Henshaw take over as adviser. But Henshaw was becoming less enamored of insect extermination and had cooled to the idea of entanglement with the work as he became more involved in his duties at Cambridge. On June 18, 1891, Fernald was conscripted to act as the committee's adviser, making official the relationship that had existed unofficially since before the first commission was formed. Fernald accepted this obligation with reluctance and only after considerable persuasion by committee members, notably Nathaniel Shaler, who could twist an arm like few others. As Fernald said some years later: "I was invited down to meet [the committee] and they asked me to act as their entomologist, and I consented to do so after considerable urging on their part. I knew very well that it . . . was not to my advantage. It was a care and labor which I dreaded, but I entered into it in good faith and I have given this insect the best study of my life."[26] Fernald became very active in this capacity, visiting the field on many occasions and making suggestions and recommendations. This burden became so great that he had to be assisted by one of his most talented students, Ephraim Porter Felt, who later served as the state entomologist of New York. Fernald also had to engage a man to take his place in Amherst whenever he was in Boston, and for the duration of the campaign he paid for his substitute out of his own pocket.[27]

In Washington, Riley pondered what to do once officials in Massachusetts had accepted the failure of chemical extermination. He had corresponded with the Reverend Henry Loomis in Yokohama, and during a visit to Washington, Loomis delivered some cocoons of the Apanteles parasite. Riley sent these to the gypsy moth committee, although no living insects emerged. During the summer Loomis also shipped Apanteles pupae to the Board of Agriculture in Massachusetts, but Sessions and Fernald made no mention of receiving them.[28] Loomis sent Riley some Japanese gypsy moth larvae as well, which arrived after Riley returned from Medford. None of the larvae was parasitized, but Riley believed that although they were of a different species—*Ocneria japonica*, larger than the European variety—the two species were related so closely that whatever insect parasitized one would also attack the other.

Travels Not Taken

The weakness of the chemical extermination strategy placed Fernald in a heightened state of apprehension. After receiving Sessions's letter of March 17 and continuing until the end of July, he tried without enthusiasm to arrange for shipments of parasites from other countries. Riley, Henshaw, and he held a series of discussions about who should travel to Europe. Fernald, who had the advantage of the long summer recesses observed by the colleges of his

time, could travel abroad between semesters and was no stranger to European entomologists. But he wondered how he could spend time overseas during the heaviest gypsy moth work and concluded that travel might not be possible for him. Henshaw did not want to go but said that Riley would make the trip instead. When Riley learned that Fernald had deferred to him, he wrote the professor to express mixed feelings about taking such an important role: "It is hardly accurate to say that I wanted to go. I urged that the effort not be postponed and also urged you as the best man available for the mission. I expressed my willingness to go on certain conditions, as, while the trip would be pleasant I should have to make many sacrifices in other directions."[29] Riley went on to express his belief that the matter should not be delayed, and that so much time had already passed it was not his willingness but his ability to make the trip that was the stumbling block. He reiterated his feeling that Fernald should go or, if that were not possible, send a trusted agent. He concluded by stating his wishes for Fernald's success, and added, "If I can be of any service in one way or another, command me."[30]

Fernald, unable to delegate anyone to go to Europe and arrange for parasite shipments, quickly lost what little interest he had in the idea. European entomologists considered the usefulness of imported parasites against the gypsy moth to be practically nil, and Americans regarded the idea of going abroad for this purpose as either a waste of time or an opportunity for a leisure voyage at somebody else's expense. The problem, as Fernald remarked a few years later, was that he could not get any qualified entomologists to take the idea seriously: "During the course of the work on this insect several very competent men offered to go abroad to bring over parasites. . . . When these cases were carefully examined it was found they wanted to take a pleasure trip to Europe at public expense. Prof. Riley wrote me frankly that he was getting tired and needed a few months rest and if he could get a matter of $15 a day he should like to go."[31] But Fernald clung to the idea that native parasites should be given a chance to prove their effectiveness and that otherwise the work against the gypsy moth, if not going very well, was at least going well enough. Riley was bewildered by Fernald's logic, as he mentioned to his staunch friend Henshaw: "I am utterly amazed at Prof. Fernald's published statement, which does not at all agree with what I saw myself and what you saw with me. . . . [I]f Professor Fernald considers that a Tachinid, which is in all probability a general parasite, will be of greater value than any foreign species could be, and if it is for this reasoning that he bases the action of the committee in deciding not to introduce any European parasites this year, all I can say is that his position is very weak indeed."[32]

Rising Birds

At about this time, workers noticed birds appearing wherever larvae were concentrated, and within the year more species were seen to feed upon the caterpillars in Massachusetts than in Europe. Forbush wrote: "Unfortunately, there were at that time only eleven observers on the force who could accurately identify birds in the field. . . . The notes made by them indicated that thirteen species of birds were feeding upon the moth in one or more of its forms."[33] Forbush required that any species of bird seen taking the larvae, pupae, or imagoes be reported to him at once. News from the field confirmed that cuckoos relished the larvae, eating up to twenty an hour and bringing numerous catches to their young. In fact, the cuckoos ate so many gypsy caterpillars that their stomachs were lined with the larvae's body hair. The gypsy moth workers loved the cuckoos, and as Forbush later wrote, "a gathering of cuckoos anywhere was looked upon as a sign of a caterpillar outbreak."[34]

Investigations soon revealed other birds too were taking hairy gypsy caterpillars. Baltimore orioles were adept at plucking larvae from their hiding places beneath the burlaps; bluejays were prized because they searched bark crevasses, cracks, and holes in trees for hidden larvae; and crows enjoyed snatching larvae that were hiding under branches. Catbirds flocked to infested areas and plunged without hesitation into the densest thickets and heaviest underbrush to pluck out both caterpillars and pupae from otherwise inaccessible concealment. Chickadees fed on the pupae and were seen taking female imagoes. Redstarts, kingbirds, and flycatchers took male moths on the wing. Red-eyed and yellow-throated vireos, always known to feed upon the hairy tent caterpillar, also found the gypsy caterpillar to their liking, and in voraciousness they were second only to cuckoos. Scarlet tanagers proved to be insatiable: Forbush recorded a single male tanager that ate thirty small gypsy moth caterpillars in five minutes and continued eating at that rate for eighteen minutes more.

Hot Spots

Despite the activities of birds and the labors of men, hot spots kept popping up all over the region that required teams of men deployed in one place to give up their work and rush to another. One such hot spot was in Arlington, about two miles due west of Medford, where a contingent of caterpillars was found attacking a grove of trees. The trees were sprayed, but spraying failed to kill the larvae, which then consumed the grass as they dispersed into the nearby woods. As the battle continued, sprays and fire killed uncounted thousands of

larvae, but thousands more survived to pupate in mid-July. The area was stony, and large numbers of caterpillars crawled beneath the rocks to pupate. Workers rolled field stones over and collected the pupae underneath at the rate of about one every three seconds, averaging eleven hundred per hour per man.

Another hot spot occurred in Swampscott, a seacoast community between Lynn and Marblehead, where a gang sprayed so extensively that the larvae became soaked with Paris green. When this failed to kill many, the entire location was drenched again. The battle continued until the larvae had stripped all the leaves over an area of three or four acres; the caterpillars appeared in such massive swarms that spraying with contact insecticides killed two bushels of them on just a few apple trees. Finally, six gangs of men with oil sprayers arrived to burn the larvae, all the underbrush, and anything else on which the insect might feed. At the H. W. Spurr estate in Arlington, field workers carried out pupae by the basketful and destroyed them by fire.

While these nasty little fights were taking place, the larvae were successfully pupating in the areas the men had abandoned.

The last female moths laid their eggs during the second week of July, and the major battles of 1891 ceased. About sixty-five men were dismissed and sent home. The remaining hundred or so men began to kill egg masses and clear brush, their numbers dwindling as summer turned into fall. Henshaw observed the search for egg masses as part of the report he was preparing for Riley: "The probability of the detection of every egg mass scattered over an area of fifty square miles seems very small, especially when it is remembered that they are placed in almost every conceivable situation upon the trunks, branches, and even the leaves of trees and shrubs, upon fences, the sides of houses, under stone walls, piazzas, board walks, etc. So far as my observations go the search for the eggs has been carefully done, though I have found masses of the eggs after the inspection of the locality had been completed."[35]

After the larvae pupated, the intensity of the conflict temporarily died away, but the attacks against the gypsy moth had left their mark on an outraged and horrified public. In comparison with this most recent work, the doings of Rawson's commission seemed benign and innocuous. Poison had flowed in copious amounts from the nozzles of the spray wagons as the chemical was sprayed repeatedly in a vain effort to kill the larvae. The spraying of ornamental and fruit trees in private yards had left houses and fences with grayish-white streaks of arsenic. Many cases were reported of residents and workmen sickened by accidental contact with the spray, but these instances were downplayed as much as possible because arsenic was believed to be the only useful chemical available. At least three cases of poisoning could not be easily dismissed, however: these occurred to several women who had arsenic

blown in their faces by capricious shifts in the spring breezes during spraying. The skin on the faces of two of the women had erupted into terrible blisters; the third, an older woman, was so severely affected that she almost died.[36]

The public was beginning to demand work in natural controls, but Sessions called upon Fernald to submit a report that would justify continued spraying. Fernald sent the report to Boston in early August, and Sessions replied: "Your report received just now. Thanks for the same. As Shaler says, if we have your approval we are willing to face the whole crowd of objectors including H. S. Official Entomologists. It will give us standing with the legislature next winter and with the people of the state who must pay the bills."[37]

In September, while Shaler was in Washington, he called on Riley at the Department of Agriculture. The meeting did not go well; Shaler again complained about the publication of the stenographic transcript in *Insect Life*, and Riley wrote to Henshaw shortly afterward that there was no reasoning with Shaler, whom he found opinionated beyond any rational justification and who had forgotten Riley's offer to submit the transcript to all concerned parties for verification. Riley told Henshaw, "I know that it is a truthful report as far as it goes, and if it had been a complete report of all that was said, I think Prof. Shaler would have had more reason to be offended."[38]

From November 20 through the end of December, about forty of the most experienced workers were deployed to make an inspection and were instructed to move outward from each infested town until they reached a town that was not infested. The moth was found in three additional cities, four additional towns, and two wards of Boston. Consequently the area occupied by the gypsy invaders was redrawn to include about two hundred square miles. The inspectors worked in haste to have their results tallied by January 1, 1892, so that the legislators would have their report by the fourth Wednesday in January; hence, many infested places were overlooked, and the report served to approximate the size of the infested region without accurately describing its condition. The constraints placed on Forbush caused him to ignore the wooded sections thought to harbor moths. This final inspection as well as all those made under his direction during the year had been limited to "the neighborhood of traveled highways."[39] It was also learned later that even Forbush's most experienced men were not as qualified as had been thought, and colonies sometimes escaped detection for several years.[40]

All those involved in the campaign at the highest level simply ignored everything that had gone wrong and claimed that the year's work had been a great success. The committee was not embroiled in any major scandal, and the gypsy moth was believed to be less invincible than had been thought. Forbush wrote that the limbs of trees in infested orchards that had given no harvest the previous year had actually broken down under the weight of all their fruit.

The moths had been so decimated by the fieldwork that examples of their destructiveness could be found only in Arlington and Swampscott. Sessions was sure the remaining pockets of infestation were very small, and he hinted that the remainder would be exterminated the following spring.[41] He boasted later that if all the eggs destroyed in 1891 had hatched and the caterpillars had survived to full growth, their aggregate weight would have been one hundred tons.[42]

[CHAPTER 8]

The Cyclone Burner (1892)

THE MEMBERS of the gypsy moth committee were encouraged by their apparent successes in 1891, but there were aspects of the situation that continued to trouble them. Although they had begun their tenure with disdain of the first commission's methods, within the year they were doing much the same things themselves—spraying everywhere, felling trees, and setting the scrub woods on fire. They had to admit that they found conditions greatly improved wherever the first commission had worked, but there was ample evidence that the scientific guidance that had failed Rawson had failed them as well. Every passing day seemed to reveal some discouraging news. Eggs hatched in fields that had been burned over twice the previous year, and the fecundity of the moth never ceased to dismay them. The spraying on which they relied once again proved ineffective. Gypsy larvae ate great quantities of the poison without succumbing to its effects even though smaller doses killed canker worms, tent caterpillars, and tussock moth larvae. The mobile spraying squads were kept off balance the entire summer, dashing from one spot to another, spraying with little effect and without ever finishing their task.

Riley had been in the state late in January to give a talk before the Massachusetts Horticultural Society in which he expressed his fear that the gypsy moth was now "beyond control," and absent a massive and well-funded effort he could see no reason for further attempts to exterminate it.[1] He also complained to Henshaw that he had noted "a concerted effort to misrepresent and pitch into me" by members of the gypsy moth committee. The positions taken by Fernald and the apparent lack of knowledge he saw in Forbush represented a growing concern for him. He noted that an interview Forbush had given the *New England Farmer* contained "a long list of mis-statements" to which he felt obliged to reply, and he urged Henshaw to do the same.[2]

After 1891 the use of Paris green as a gypsy moth insecticide was for the most part abandoned. This was a heavy blow for the committee to bear, since Paris green was the best pesticide available, and there was nothing to replace it except London purple, a concoction with even worse phytotoxic

characteristics. An apologetic Forbush wrote in his annual report for 1892 that the committee had sprayed only because it was "the method that had been most strongly recommended by the best authorities."[3] This was doubtless a sensitive issue all around, since the "authorities" were Fernald and Riley, two of the best entomologists in the country. The state of affairs unsettled Fernald, and after 1891 he began to have anguished doubts about the prospects for victory. The course of events had left him without alternatives, and he wrung his hands in frustration: "I tried [more experiments] myself and did not believe my own eyes, and tried it a second year, till I was convinced we had an insect that could eliminate more poison from its system than any insect I had ever before dealt with. Then the question arose, what could we do? What could we do if Paris green, the best insecticide known to us, would not destroy this insect? How could we deal with it?"[4]

The duties thrust upon him by the gypsy moth committee burdened Fernald, who was having difficulty finding enough time to meet his educational demands. He was going through an unhappy period at Amherst and had decided to leave that institution. He thought that a closer association with state work might solve his problems, although the question of his compensation had not been resolved to his satisfaction. On January 25 he wrote to Sessions about working out some arrangement to free him of his college duties while the campaign against the moth was in progress. Sessions begged off by saying he would have to discuss it with Shaler, who was out of town:

> I fear the trustees, president and faculty would be down on the committee if we arranged such a bargain. The people of the state would not relish your absence from the Hatch Station. Nothing I am sure would please the committee on gypsy moths more than to have your constant participation in their work. It would give us greater strength and prestige with the Legislature and the public. But the committee on agriculture have not yet acted on our appropriation and until we know what funds we are to have at our disposal we cannot "talk business."[5]

It was dawning on Forbush and Fernald that successfully concluding the war might take much longer than they had considered. To get the job done would require meticulous attention to matters of the finest detail, and forces under the committee needed to be increased in number and given much additional training. Men would have to be hired permanently to keep from losing them. Appropriations would have to be large enough to cover the payroll for twelve months and work enough found to keep men busy all year.

Efforts in the field had proved time-consuming. It took four men a full hour

to spray a single tree to Forbush's demanding standard. Not spraying correctly was worse than not spraying at all, since the tree would have to be sprayed again. Clearing a large roadside tree of egg masses also could take up to an hour if the tree had to be climbed, and a heavily infested tree took even more time and required an extra man. An experienced worker needed twenty minutes to clear egg clusters from an average fruit tree. If he worked nine hours without stopping, he might clear twenty-seven trees a day, a level of performance that was seldom approached in actual practice. Moreover, after the first man was done, a second of greater experience would have to examine every tree cleared and, if this second inspector found egg masses, he would have to clear the tree again, after which a third senior employee would perform another inspection. And there were millions of trees that needed attention.

Throughout the winter, the committee, its field director, and its entomologist devised their strategy for the year. The last scouting had been tabulated, and for the first time since the war against the moths began, the committee believed it finally knew the area occupied by the insects.[6] The field force would be used in the inhabited areas to hold the insects in check where they were most numerous. This would buy time for the field director to recruit and train a permanent force of men and for Fernald's staff at the research station to develop new approaches to extermination. The committee did not seem concerned if all the work could not be done at once, claiming that "Experience [has] shown that the moth can be eradicated, that it has been destroyed in many limited fields."[7]

The weather turned against the exterminators during the winter, often forcing a halt to egg destruction and further inspections. When possible, masses on trees along the roads were destroyed in order to lessen the chance of larvae spinning down onto passing wagons during the spring hatch. This emphasis on roadside work was done to compensate for the discontinued roadblocks. Before the hatch the trees were wrapped with sticky bands, which the committee hoped would provide a seasonal barricade that would not need to be checked every day. Through the winter of 1891–92, Forbush kept fifty men at work in Medford and Malden, believing that the concentrated efforts of even a small force could make a great difference. Although he was bound to Fernald's scientific point of view, Forbush had been impressed by the simplicity and effectiveness of burlaps and soon became a convert to the effectiveness of killing egg masses. The techniques were neither technological nor scientific, but they always worked. He noted in his annual report that if he had been able to send one hundred men to attend burlaps in Medford and Malden in the fall of 1891, the moths there could have been exterminated by that work alone.[8]

The committee and its leadership believed they had given a beating to the gypsy moth the previous year, even if it had been the result of archaic tactics. Had they been more experienced, they would have known that after a few years of massive outbreaks, moth populations generally declined for the next few years or even a decade, and during these periods the moth presented itself in a very innocuous way. Thus, the committee, perhaps lulled into a false sense of security, requested only $75,000 for the new year's work. The members thought more funding was not needed because of Forbush's difficulties in filling the ranks of his field force, and they were concerned that the state legislature, which was hoping for quicker and more favorable results, was becoming anxious about the amount of money required to destroy the moth. Although aware that the requested amount was too small, the committee later publicly blamed many of the year's disappointments on the lack of an adequate appropriation. This began a long-running and damaging confrontation with the legislature over the amount and timeliness of moth funds.

Shaler, who lived within the infested district, gave more time to his duties than most committeemen and claimed he had spent hundreds of hours examining the work in progress. The Board of Agriculture had been stung by the criticisms expressed in Henshaw's report to Riley, and every man on the committee regretted his decision to work without a salary. Each one felt he had put in too many hours, and one testified before a legislative hearing that the committeemen now believed they should be paid for their work.

The committee had managed to conserve a little over $5,000 from the appropriation of 1891, which it used to retain about forty-five experienced men at an average pay rate of $2.25 per day. These men did what they could, but heavy snows late in the season hampered their mobility. The committee presented its request for an appropriation as soon as the legislature convened in the early days of January 1892. But the $75,000 asked for was not granted in full until the first of March—a date the committee considered late, but it proved to be one of the earliest release dates and allowed work to start sooner than was possible in subsequent years.

The speed of legislative action was not nearly fast enough for Forbush, who had dismissed his best forty men at the end of January when his funds ran out. He complained that he was "obliged to discharge many faithful, efficient and experienced men, for want of money to pay their wages."[9] Most of these men found work elsewhere before money became available on March 1, so Forbush had to seek new men and train them. The rigorous screening of potential candidates, including new character references that he had set in place that year, further slowed the process of rebuilding. Most of the men were rejected for poor eyesight; a large percentage was eliminated for causes that were not made public. Forbush hoped that these new hires would be employed by the

state for the duration of the campaign. He wanted a dependable, stable group that would allow him to reduce the considerable amount of time that the experienced men were taken from the field to train the recruits. He considered the force hired and trained for 1892 to be one of the best ever to take the field, although its small number and lack of experience hampered it: "The inspection was not in all cases thorough, as a large proportion of the force engaged in it was necessarily composed of inexperienced persons, and there were not enough expert men to reinspect their work. Thus we were unable in the spring of 1892 to do thoroughly the work which might have been done in the fall of 1891 had sufficient money remained. We were also unable to secure and train men enough, in the short time at our disposal in the spring, to cover the entire field."[10]

Students from the agricultural college were still used to augment the field force during the summer, and each one was brought in at the rank of inspector and given charge of a section one mile square. This caused some resentment among the older men who did not like being directed by "boys," but the result seems only to have been a lot of grumbling. The young inspectors and their gangs had authority to "enter any place and do whatever we think necessary to destroy the eggs."[11] One young student wrote a brief account of some of his experiences for his college magazine, *Aggie Life*: "One or two have threatened to shoot the inspector if he came into his yard. Many inquire about the work and wish us success. . . . [W]e are obliged to go under all piazzas, to take the base boards off from picket fences, or sometimes to take a fence down entirely. In these cases the owners often object, sometimes with quite strong language, but when they see we pay no attention to them they give us no trouble."[12]

One inspector, S. R. Huston, said so many men had been hired to kill egg masses that the payroll quickly depleted the budget, causing a large percentage of the men to be laid off, and leaving too few to attend the burlaps. Huston did not believe that extermination was possible and said hardly anyone else believed it, either. Citizens freely expressed these opinions, but the workers did not. Employees did what was asked of them and gave the state a good day's work. The uncertain status of their jobs dampened their enthusiasm, however, and the constant layoffs made a career with the gypsy moth committee undesirable: "They hire three hundred men in June; discharge two hundred of them in August. . . . Two men dismissed claim to be equally as efficient as [one] retained. So the men in the summer know the place is only temporary and they do not care much. . . . [T]he majority of people were indifferent in regard to the matter and do not believe in it. They do not have any objections to the commission. They say, 'well, it gives employment to men so it does some good, but I don't believe they will exterminate the moth.' "[13]

The failure of pesticides caused renewed interest in natural predators and parasites, although such work was incidental because of the mandate for extermination. Five species of beetles and a number of spiders were seen eating caterpillars, but their effect was deemed slight. Fernald instructed workers to begin sending egg masses to field headquarters, where they could be inspected. He and his assistants examined twenty thousand eggs individually, found only one that was parasitized, and discontinued the effort.[14] Several parasites that attacked the gypsy moth pupa were discovered. Afterward, all dead pupae found in the trees of the outlying districts were presumed to have been killed by parasites and were left untouched so that the parasites could escape; all other dead pupae were collected and examined in the lab for signs of parasite attack. Fernald consulted some American specialists, Dr. W. G. Farlow and Dr. Roland Smith, about the use of "vegetable parasites" (molds and funguses) to control the gypsy moth and was told it would be a waste of time.[15]

His query about vegetable parasites reveals an intriguing side of Fernald: he investigated the subject of natural controls throughout the campaign without allowing any work along these lines to be implemented. In his capacity as entomologist of the Hatch Experiment Station he was free to pursue such work but not with funds appropriated by the General Court for extermination. He looked for the presence of disease as well, both as a hopeful matter for control of the gypsy moth and as an unwanted agent that might destroy predatory insects, but apparently never found anything conclusive. As he wrote to R. W. Glaser some years later: "I went down there every week and was around with the men in the field in every part of the infested region, and if they or the field director had noticed anything of the kind [disease] they would surely have told me, for they all knew that we were hunting for and breeding all the parasites we could find."[16]

Through *Insect Life*, Fernald kept abreast of the correspondence between C. V. Riley and Henry A. Loomis in Japan and of their attempt to bring Japanese parasites to America. On September 1, 1892, Loomis wrote to Riley: "I still believe the Ichneumon fly found here will destroy the Ocneria dispar. It will require demonstration to prove the contrary, as their food and habits are identical as far as I can learn. It is the destructive power of this microgaster that prevents the moth from being a formidable scourge in Japan. It is really wonderful how effectively it works."[18]

The committee asked Fernald to make a "close and critical" inspection and submit another report on the subject of importing parasites. He did so but consistently continued to recommend against importation. His opposition puzzled the committee and a number of scientists who asked what the compelling drawbacks were. Fernald presented the weak explanation that he wanted first to see whether native parasites would increase in number: "After

A cyclone burner in use against egg clusters in a rock wall, circa 1892.
From *The Gypsy Moth.*

making a close study and finding that our native parasites were at work on the insect it seemed to me that it would be wise to wait a little before attempting to import others, as there seemed to be a danger that secondary parasites might be imported with the primary ones and thus undo all that we attempted. My advice was taken in that case, whether rightly or wrongly remains to be seen."[17]

The Cyclone Burner

The committee had a deadly surprise called the cyclone burner waiting for the enemy this spring. The new device consisted of a small-aperture cyclone nozzle at the end of a twelve-foot iron pipe that was connected to a wooden vat by a short length of rubber hose. The vat was fitted with a hand pump and held fifteen gallons of paraffin oil. The apparatus was light enough to be moved into the field by two men, one who operated the pump and one who held the metal wand wrapped in an insulating wooden handle. A match ignited the vaporized oil spray, and the flame produced was so searing that not even a gypsy moth egg mass could withstand it.

Although the device was imperfect—the oil quickly corroded the rubber hose and clogged the nozzle—the burner was celebrated as a potent new weapon. It all but replaced the naphtha burner as a mass destroyer of egg

clusters. The flame would be swept along the ground, a technique called "blazing" by the men, incinerating whatever it touched and killing every living thing in its path. Only eggs deposited under rocks might escape, although the hellish fire often shattered the rocks. Intended as a device to incinerate egg clusters in leaf litter, the burner also proved effective where swarms of live caterpillars occurred on the ground. Osgood called the flame of this device "fearful."[19] And when Fernald witnessed the first demonstration of the cyclone burner, he could not believe his eyes. He later remarked to his colleagues: "We have a method of burning which I can not describe. It approaches as near the Tophet as anything I can think of. It is the most terrific blaze I have ever seen."[20]

The apparatus weighed 150 pounds when loaded and used fuel at a prodigious rate: to burn over an average pasture required filling the tank fifty times and consumed 750 gallons of oil.[21] The fine paraffin had an unpleasant odor, and it soaked into the clothing of workers, who were obliged to dress in heavy rubber coveralls or full body "oil suits" and boots to keep themselves from igniting. Working in smothering garments next to the searing heat of the cyclone burner during the long, hot days of summer taxed the endurance of the men greatly. The burner was an awkward size, and the pump operator had to work bent over in an uncomfortable position with one foot on the lid of the keg to keep it from lifting during the upstroke. When blazing the walls surrounding farms or gardens, they had to carry a large metal sheet into the field to set behind the rocks being flamed so that crops would not be damaged. Most workers did not view being on a cyclone burner crew as an enjoyable way to spend their summer.

When not needed for its flame, the cyclone burner could be converted into a lightweight sprayer. Crews liked the twelve-foot pipes because many trees could be sprayed to their tops without climbing. (Even spray crewmen chosen for their lightness and agility still damaged the limbs of many smaller trees, such as those growing in orchards, when the tree had to be ascended, and the climbing irons they wore made holes in the bark that provided entry for other insects and disease.) The burner pole could be fitted either with the specially made four-headed cyclone nozzle or, when a vaporous spray was desired, a modified Vermorel or Riley nozzle. The fine mist discharged by these nozzles blew away easily in the wind, however, so spraying from the downwind side was a tricky proposition.

The state equipped its forces with special mirrors to aid in the inspection of inaccessible places, and with pocket tins that contained a pair of metal tubes with brushes attached to their caps. One tube held creosote for poisoning eggs and the other held white paint with which workers painted a ring around treated egg masses. About 100,000 fertile egg clusters were destroyed, considerably fewer than the year before. This reduction may have been due to the

effects of the previous year's work, a natural decline in gypsy moth numbers, or the use of the new cyclone burners, since incinerated masses could not be counted.

The caterpillars swarmed again during the late spring and summer, but their activity seemed more localized than in past years. Winchester was experiencing heavy infestations, and thousands of insects completely engulfed the spruce trees in front of Louis Goddu's house.[22] Swampscott was becoming a perennial hatchery for the insect because the terrain there made cleansing work very difficult. As A. R. Bunting, chairman of the Swampscott Board of Selectmen, stated: "The gypsy moth caterpillars were very thick in the spring of 1892 at the Marshall place on Humphrey Street. The trees for two or three acres were stripped of their leaves. It looked as if a fire had been run through them. There was no more sign of a leaf in May or June than there would be in February."[23]

After the spring hatch, there was no intense spraying with Paris green as had been done earlier. Only two sprayers were in use—equipped with the latest nozzles, replacing the garden hose nozzles used the year before—and then only where infestations were heavy or concentrations of larvae warranted the use of contact insecticides. Most of the state's spraying apparatus remained in storage at field headquarters at Malden while the forces wrapped 150,000 yards of burlap bands around thousands of trees: "The habits of the caterpillar are such that the method of banding the trees with burlap appears the most effective one yet devised to dispose of this form of the moth. . . . [B]urlapping and hand-killing disposed of nine-tenths of the gypsy moths in the infested region during the summer, and in many localities they were exterminated by this work alone," the Board of Agriculture reported.[24]

During the summer, chemist F. C. Moulton began experiments with substances that might be effective at destroying egg clusters. He tested some fairly ghastly chemicals—benzene, bromine, chlorine, carbon disulphide, hydrocyanic acid, hydrogen arsenide, hydrogen sulfide, potassic cyanide, and hydrochloric acid—most in both liquid and gaseous forms. Harry B. Ramsey recalled that Moulton's experiments were sometimes spectacularly unsuccessful: "Mr. Moulton was a very quiet, modest person who evidently was bound up in his profession and did not mingle with the men in the field. He had a small room partitioned off in the storehouse, which was an old livery stable on Commercial Street, Malden, Mass. Several times during these experiments there were explosions heard from his room, and men working on tools would have to go outdoors until the gasses evaporated."[25]

Nathaniel Shaler discovered that inexpensive creosote oil, manufactured by the Carolina Oil and Creosote Company in Wilmington, North Carolina, worked best at soaking into the egg mass and killing all the eggs. Thinning the

oil with carbolic acid and turpentine allowed the mixture to be used effectively even during the coldest months. The formula later included 10 percent coal tar, which darkened the masses and allowed workmen to see which ones had been treated. The poisoned egg masses could then be left in place, saving time and allowing the fieldworkers to unburden themselves of the clumsy egg-burning ovens they had previously used. Leaving the egg masses also allowed workers to compare the number of new ones with the old to determine whether moth populations were increasing.

The late summer inspection cost a considerable amount of money, and as a result most of the workers were let go at the beginning of September. The forty to fifty men remaining gave as much time and attention as possible to expanding this inspection, and the spotty review did produce some good news: the boundary of 1891 had held, and all new infestations were still contained inside it. Although 1892 was a light year for gypsy moths, the committee took credit for a 90 percent reduction in the moth's numbers. The efficacy of the cyclone burner and of applications of burlap and sticky tar, the reduction in larvae, and the containment of the insect's outward spread greatly heartened the committee. In June 1892, Fernald made a personal inspection of Medford and was elated by what he saw. The town for all practical purposes had been wiped clean of gypsy moths. "I scarcely found an insect," he said happily.[26]

The sagacity of the economic entomologists seemed to have been confirmed at last. Some residents of the central infested towns were finally experiencing relief from the caterpillar swarms and were grateful to the state for taking on the work. Rose A. McCarty of 26 Myrtle Street wrote to the committee that in the fall of 1892 she and her family had harvested their first crop of apples in seven years.[27] M. M. Ransom of 18 Lawrence Street in Medford wrote that although the work of the gypsy moth commission had killed two of his trees, "I do not consider that I lost the two trees, but rather gained the rest, which would have been lost save for the work of the [gypsy moth] department."[28] Others said that if gypsy moth gangs had not worked on their properties, they would have been forced to sell their houses at a great loss and move away.

Forbush's small budget altered his plans to create a standing army. A force of 235 men had been put to work that spring banding trees, after which many were dismissed only to be called up again to tend the burlaps. The force was reduced after the caterpillars pupated and then increased once more in September to conduct inspections that had not been done the previous winter. Workers left the force the moment they could find stable employment elsewhere, and the task of training new hires became one that continued through the years. Forbush complained that it made no sense to discharge the best men at the end of the year, and that if the force had to be rebuilt anew each spring, weeks of valuable time would be wasted training the recruits.[29]

The gypsy moth committee still considered the outcome of 1892 to be in its favor and expressed optimism that eradication remained a viable course. That fall, Fernald, Forbush, and four men spent three days in Medford looking for egg masses and were able to find only two. Fernald, who had been the first to call for extermination and later changed his mind, changed his mind again: "While I have for some time had grave doubts of the possibility of complete extermination, I am now led to believe that such a thing is really possible, provided the work be continued for several years with sufficient appropriations to keep the entire territory under careful supervision."[30]

Forbush took pains to note that in the entire infested region, thanks to the work of the field force, these formidable insects had perceptibly injured fewer than twenty trees.[31] He thought that infested towns on the perimeter should be cleared of moths by the end of 1893, and that the moth ought to be rare everywhere in another year. He claimed that 99 percent of the egg clusters had been destroyed and that colonies in more than three hundred locations had been exterminated. He boasted that wherever the caterpillars swarmed in greatest densities, "it was comparatively easy to reduce their numbers."[32] Given what he termed a trained and efficient force, total extermination would occur over the next several years: "[The committee] believed that they had now learned by experience how to eradicate the moth. A large number of colonies had already been exterminated, and it had been proved that the moth could be exterminated wherever it was found."[33] In his portion of the annual report for that year, Forbush expressed his belief that few people outside the Board of Agriculture appreciated the magnitude of the work and mentioned that if the committeemen had known the moth's full distribution at the start, not one would have had the courage to attempt extermination.[34]

The Metropolitan Park Commission I

Looming ominously ahead of the committee, however, were large, wooded areas that lay within the infested region. The most prominent of these was the Middlesex Fells, a rugged, rocky tract of 3,200 acres bordered by the five most infested communities in the Commonwealth: Malden, Medford, Melrose, Stoneham, and Winchester. It lay in the hills that surrounded Boston on three sides, and its scenic features, rivers, lakes, and magnificent trees made the area desirable as parkland and a watershed for the growing city. The Fells constituted the second largest of the wooded parkland "reservations," exceeded only by the 4,190-acre Blue Hills. But other large tracts such as the 2,000-acre Lynn Woods were also inside the 1891 boundary.

The citizens of the area loved the Middlesex Fells as one of the few remaining, large, open spaces convenient to Boston. Special laws had protected the

Fells since the middle of the seventeenth century, and the woodlands had been held in common for the first 150 years of European colonization. Hog and cattle reeves were mandated to keep livestock out of the woods, and the opportunistic cutting of trees or kindling of fires was punishable by fines. Forbush said the Fells enclosed some of the finest trees in the eastern part of the state, and that their loss "would be considered a calamity by the citizens"[35]—without noting whether any such losses would come as the result of the gypsy moth or of his chopper gangs.

There was dismay, then, though little surprise, that the gypsy moth was in the Fells, since the southern boundary of the woods was less than half a mile from Trouvelot's former residence on Myrtle Street. The committee did not want to combat insects in wooded lands, but the Fells provided the gypsy moths with a stronghold from which they could swarm every year, not to mention the possibility of high tree mortality within the reservation itself. By this time the committee's favorite method of attack in any infested woodland place consisted of clear-cutting the trees after egg-laying time, followed by a complete burning of the land in winter and a second burning in the spring—in effect, saving the forest by cutting down the trees. The committee proposed to take this course of action in the Middlesex Fells during the winter, a task it told the legislature could be done for a an estimated cost of $400,000.

When word of this plan got out, however, there was uproar from the public and from those in charge of the reservations.

At this time, stewardship of the Middlesex Fells was passing from various individual owners into the hands of the newly created Metropolitan Park Commission (MPC).[36] The Massachusetts legislature had set up a temporary commission in 1892, with influential *Boston Herald* journalist Sylvester Baxter serving as secretary; he became chairman on June 3, 1893, when the MPC became a permanent commission. The mandate of the park commission was to acquire and develop a series of large spaces around Boston for public use, and it had just made its first three major land acquisitions for this purpose: Beaver Brook, Blue Hills, and the Middlesex Fells. Commissioners Baxter, Charles Francis Adams, Philip A. Chase, William B. de las Casas, and landscape architect Charles Eliot were not about to allow parkland trees to be felled wholesale.[37]

The creation of the long-awaited parks commission thus presented unexpected and unwanted complications for the gypsy moth committee. The MPC commissioners and their supporters were drawn from the highest social and political levels of the state, and they and their parkland acquisition program generally enjoyed strong legislative, public, and private backing. The members of the gypsy moth committee and the State Board of Agriculture were mostly small businessmen and farmers whose program of moth extermination was

not generally understood or appreciated, who drew little public support, and who were increasingly at odds with the legislature.

The appearance of the gypsy moth in the Fells caused the mandates and methods of the two boards to come into conflict. Clearly, imposing the moth committee's methods of work on the parklands would have come at great financial and political cost. At some point it became obvious to the committee not only that the MPC would have the last word in this matter but that the state legislature would not give serious consideration to such a large additional monetary request. The plan to log and burn the Fells was quietly shelved.

[CHAPTER 9]

Lead, Arsenic, Burlap, and Fire (1893)

THROUGH SESSIONS AND SHALER'S skillful maneuvering and considerable influence, the gypsy moth committee continued to enjoy the support of the state's highest elected official. Speaking before the combined house and senate on January 2, 1893, Governor Frederic T. Greenhalge encouraged the legislators to support the extermination campaign, noting that the situation could not be resolved by partial measures:

> The ravages of this insect have undoubtedly been restricted and minimized, but no precautions have been sufficient to prevent its doing considerable injury. The area of its depredations has not been extended, which is the main feature of encouragement. Upon the whole the weight of scientific testimony, and the best practical judgment seem to favor the continuance of our labors in the direction already taken. To what extent, in what manner, and at what cost this perplexing task is to be prosecuted must be determined by your wisdom, care and experience.[1]

At the annual meeting of the Board of Agriculture in Boston on February 2, the gypsy moth committee was increased in size by two, with E. W. Wood of West Newton and William H. Bowker of Boston joining Sessions, Shaler, and Appleton. During the winter, Fernald continued to test Paris green at Amherst, at last resigning himself to the reality that his best insecticide was largely useless against the gypsy moth: "Experiments with Paris green, repeated each year since the work began, have shown that this substance, in any proportion that will not greatly injure the foliage, will not destroy all the caterpillars when small and only a small proportion of them when more than half grown."[2]

More legislative hearings were held in February, and the gypsy moth

committee collected statements from citizens who believed that the state's efforts against a formidable insect had staved off a catastrophe. Hearings were held every year because the state legislature did not consider gypsy moth extermination to be an ongoing program and treated each year's appropriation as a new matter. The hearings sometimes took just a week, while in other years they lasted as long as a month. From the few surviving reports one can tell that the tone of all the hearings was similar: that is, rancorous, divisive, and unpleasant.

In 1889, Fernald had indicated that the complete destruction of the moths would take about three years, with financial needs diminishing from one year to the next. The three years and more were now completed, and the moth had not been exterminated. In addition, the continued effort was requiring more money, not less, and the General Court was becoming less amenable to the matter, not more. The committee raised its appropriation request from $75,000 to $160,000 and requested that an independent committee be formed by the legislature to report on gypsy moth extermination, no doubt hoping that the results of the moth work would be favorably reported to the General Court. After the hearings for 1893 had ended, the finance committee reduced the moth appropriation to $100,000—an action the gypsy moth committee felt was caused by public opposition to the thought of burning the Middlesex Fells—and did not vote that appropriation until April 12. No independent committee was appointed.

During the hearings, Andrew H. Ward suggested an insecticide made from arsenate of soda, but it burned foliage even worse than Paris green.[3] Fernald delegated F. C. Moulton, a field inspector and graduate chemist, to find a way of precipitating arsenate of soda in water, and after some trials Moulton settled on acetate of lead. This resulted in a fine suspension of lead arsenate that did not quickly settle to the bottom of the tank, as did the coarse arsenic suspension of Paris green. On March 23, Moulton sprayed the formula on a plant in the office, marking the first time it had been tried on living vegetation and beginning a long period of experiments with the new poison.[4]

Lead arsenate was expensive to manufacture, and it worked slowly. Like other arsenicals, the new pesticide was fatal to honey bees, so orchards could not be sprayed while the trees were in bloom. Fernald found that a mixture of one pound to 150 gallons of water killed potato beetles and tent caterpillars in the lab, but it took three times that amount to kill a laboratory-raised gypsy caterpillar. The fine suspension of lead arsenate permitted the use of a tight mesh filter on the suction line, reducing greatly the previous tendency of the nozzles to foul. Forbush gave the order to modify the state's thirty heavyweight spraying rigs, which had lain idle for two years, and make them ready for use.

To the surprise of the leadership, Moulton applied for a patent on his discovery, although the effort ultimately proved unsuccessful. Fernald told his colleagues in economic entomology: "The Commonwealth of Massachusetts has entered a protest. . . . Whether the chemist will succeed in getting the patent I do not know, but I hope not. I wish him no harm, but I want this Commonwealth and other States to have the advantage of any discoveries we may make."[5]

In 1893, the legislature of Massachusetts passed a "resolve" to petition the U.S. Congress for financial help, but it died in Washington, putting Massachusetts on notice that it would have to continue the struggle alone.[6] As Riley had foreseen, the federal government could not be counted on for assistance. Petitions from the General Court of the Commonwealth to the federal government were made every year until the end of the decade, but Congress did not act favorably on any of them.

During the wait for the state legislature to act, expert men were lost to other employers, fieldwork was suspended, and fieldworkers were dismissed for lack of funds. The release of money allowed the number of fieldworkers to be increased again, but valuable time was lost while the newest employees were trained. The force of 1893 reached only 150 men at its largest, almost 100 fewer than the force of 1892. The manpower reduction allowed the committee to hoard money to buy the most accurate scouting possible of large areas just outside the boundary that had never been inspected, and it permitted them to keep the moth program going until the next appropriation was secured the following spring.

The decision of the committee to decrease their force by nearly 40 percent had also been influenced by the financial panic of May 1893 when the U.S. Treasury became technically bankrupt. Railroads, businesses, and banks failed, and legal tender for payrolls was in short supply. Under the circumstances, operating with reduced manpower and funds, the committee made a tactical decision to concentrate its forces in the outlying towns on the theory that should the moths gain in strength anywhere, it would be better if they did so in the central zones where they were surrounded. Work in Medford, Malden, and neighboring communities was abandoned except for a small number of men detailed to each place "to do all that could be done to advantage."[7] Forbush sent his men into the field as soon as they could locate egg masses in most of the common locations, relying on his core of experienced men in the second wave to pick up whatever might have been missed.

Experiments with light creosote oil the previous year had been successful enough that the fieldworkers were instructed not to scrape egg masses into cans of kerosene any longer or to burn them on the trees, rather they were to soak the masses with the killing oil, which imparted a dark, unnatural color

that alerted other workers not to treat them again. Dilute nitric and carbolic acid also were used to destroy the eggs, but creosote proved to be the most effective, safest, and the easiest to use.

The principal work of the season was placing cloth bands on the trees. Fieldworkers entered the woods carrying rolls of burlap and balls of twine suspended from a shoulder rope. Extra burlap was piled in large-wheeled handcarts that could be easily pulled across rough terrain. Burlap was wrapped around each tree at a height of four or five feet. A few inches of overlap were allowed, after which a quick slash of the knife cut the burlap to length. A piece of twine was passed around the center of the band, cut, and tied off; the top half of the fabric was then folded over the lower half.

The men became very proficient at this task and could wrap trees with surprising speed, banding almost 420,000 trees before the larvae emerged. But the small force was at a disadvantage once the larvae ascended the trees. The success of banding depended on daily visits to remove the larvae, and with only 150 men available to tend 420,000 trees, many areas received little attention. Gypsy moth gangs made specified rounds so that no tree would go more than a few days without having its bands cleared, but in the central zones some trees were checked only once a week. During the months of May, June, July, and sometimes August of every year, almost all the men spent almost all their time killing the larvae found under the burlaps in the outer zones.

Some of the remaining men were diverted to brush *raupenleim* (literally, "caterpillar glue") on the trees, further reducing visits to the burlap bands. This imported German formula, a sticky goop that clung to the tree trunk and barred the paths of ascending larvae, had proved itself so effective the previous year that the committee had imported several additional tons of it for use in the current summer. For unexplained reasons, the *raupenleim* did not work as well again. When it was troweled into the hollows of infested trees, however, it made an excellent filler that saved much time over the old ways of nailing a tin patch over the cavity or mixing mortar plugs.

A bad infestation occurred at the Harmony Grove Cemetery in Salem, where Superintendent George W. Creesy and his men had considered the gypsy moth campaign a kind of social program to give unemployed men some work. But as the moths covered cemetery buildings, fences, and tombstones with yellow nests, the astonished Creesy became "a sudden and earnest believer in the gypsy moth department."[8]

The committee elected to do little spraying in 1893 other than the field tests of lead arsenate. It took ten times the amount of poison to produce the same results in the field as were obtained under controlled conditions, and pesticide mixtures as high as thirty pounds of lead arsenate to 150 gallons of water were needed to kill gypsy caterpillars in the wild. Forbush turned the cyclone

Workers wrapping trees with burlap bands, circa 1893.
From *The Gypsy Moth.*

burners loose in great number during the summer, utilizing a method of extermination he said guaranteed "certain destruction."[9] When there were lulls in the fighting, fieldworkers took on the disagreeable task of inspecting neighborhoods for eggs and pupae amid the piles of rubbish commonly found behind houses, a task that Forbush intensely disliked: "Not only are all sorts of waste material from all parts of the house from cellar to garret thrown into the back yard, but refuse from the kitchen is also frequently deposited there, together with a collection of empty but unclean cans. . . . Old shoes, broken bottles and earthen ware, cast-off articles of apparel, corn husks and the withered tops of vegetables in all stages of decay, bones, fish heads, lobster and oyster shells are also common constituents. . . . Amid such associations the gypsy moth loves to dwell."[10]

Forbush therefore thought one way to eliminate the gypsy moth was to

eliminate garbage. Rubbish was hauled off, buried, or burned. Forbush felt such work was ennobling, saying, "Cremation is a cleansing process; bonfires mark the progress of civilization."[11] Fernald, who was less emotionally entangled in the matter, found a better use for the empty cans, placing them along infested fences, walls or hedgerows. The caterpillars then crawled inside the cans to pupate, and female moths laid their eggs in the cans. Afterward, the workmen picked them up and disposed of everything together.

The year 1893 was quiet on most fronts, although the committee remained uncertain about the condition of the woodlands and wondered if the boundary of 1891 still delineated the range of the moth. No traces of the insect could be found in ten previously infested towns, and Forbush claimed that over eight hundred moth colonies had been destroyed since the war started. He was rather casual in his definition of a colony, saying that although some were of substantial size, such as ten acres, others were "not more than a few square rods," and many consisted of no more than "one or two trees."[12] It would have been easy and tempting to inflate the count of destroyed colonies since laymen would assume that a colony consisted of substantial numbers of insects over a significant amount of territory, and all subsequent tabulations of destroyed colonies must be regarded with this in mind.

During the year the gypsy moths occupied Cambridge, and Riley wrote that the insect was spreading despite the committee's claims to the contrary.[13] Riley was still trying to obtain gypsy moth parasites from Loomis in Yokohama, but the effort was not going any better than it had before. In November he received a small box of cocoons containing parasites of the old genus Microgaster, but Loomis's attempt had failed again, for many of the cocoons were empty, and in many others the parasite had succumbed to the attack of a hyperparasite.[14]

In the fall, rail lines and rights of way radiating from the central zones were inspected beyond the state lines of New Hampshire and Maine. Men went through the towns just outside the infested outer towns, and places where light infestations had been reported were inspected again. This was a risky practice, since much of the effort did not reveal the presence of gypsy moths, did nothing to reduce the number of insects in the places where they were found, and yet consumed $13,000 dollars of a very small budget.[15] Field inspector S. R. Huston described the activities of his crew of eight men during a typical inspection: "We went to Danvers, Wenham, Hamilton through to Manchester and back to South Lynnfield and worked up through there, and finally we struck in around the northern part of Lake Suntaug and found [one] dry pupa on a pine tree. We continued our search about a week longer and found a colony of about eight or ten nests. We continued until December and

found nothing more. This was the results of three months' search."[16] Bartholomew Hennelly told about working on a crew that had been sent to inspect the infestations reported in Woburn. The woods were thick with underbrush that grew to the height of a man's head, and it had rained hard the night before:

> We must have gone, I suppose, over perhaps 40 or 50 acres of wood land to inspect it. Of course, we had not gone in there fifteen feet before we were soaking wet, and there was not a tree looked at the whole time we was in there. . . . [Special Inspector Hubbard] ordered us to separate out 100 feet apart and push right along. It was a walking match to see how fast you could walk through the woods, look at a tree here and there. Those trees there might as well never have been reported as being inspected at all, because they don't know today whether the gypsy moth is up there or not.[17]

Shaler had been tabulating the movement of swill wagons, manure haulers, and others for the years 1889 through 1893 and had sent two men to examine every place the drivers stopped to rest or unload their cargoes. This investigation revealed an old and established colony of gypsy moths in Boston's Franklin Park. New colonies were discovered near Lexington, Woburn, and Danvers, but Forbush was quick to assure residents that every remnant of the moth in those places would be destroyed by the end of the year. His answer was the inferno. He loved the cyclone burner and its capabilities, and after the eggs had been searched for with all possible thoroughness, the burlaps were all wrapped, and the spraying had done all that it could, the time was right to apply the cleansing power of the deadly petroleum blast. He wrote, "Fire can be used either to destroy the eggs of the moth, to kill the caterpillars or to starve them by burning all nearby vegetation on which they feed."[18]

The gypsy moth committee, however, becoming desperate for larger appropriations, in its annual report did not hesitate to paint a gloomy and frightening picture of what might happen should future appropriations decline or be eliminated. It predicted the "defoliation of all trees, shrubs and bushes, the destruction of fruit trees, and the despoliation of gardens." Hosts of caterpillars would bring their disgusting swarms into houses and buildings, and the stench of the dead would be nauseating.[19] The committee was feeling the close scrutiny of the General Court on the costs of scouting, the sums that were being diverted to fund Fernald's work on parasites, and the money spent on the development of unsuccessful new pesticides and apparatus. The committee kept hundreds of pages of meticulous records of all this activity and asked for

an additional $2,000 to be used in part to print the documents and in part to resume the experiments that had been discontinued because they were not in line with extermination.

The infested territory and surrounding belt of uninfested towns that had just been inspected—over four hundred square miles of land—would have to be inspected again within eight or ten months down to every last tree, shrub, fence, and stone. The examination would have to be even more painstaking than the one before so that not a single egg cluster escaped detection. The central parklands, comprising of twelve thousand acres in which grew more than five million trees and probably three times as many shrubs and bushes, had never been scouted, for the mere mention of putting even the most tangled parkland thickets to the torch had drawn a storm of opposition from the public. It would take the patience of Job, the wisdom of Solomon, and the strength of Hercules to labor through the problem of the central woodlands.

In spite of the many remaining troublesome concerns, the successes of 1891 and 1892 had continued, and the sustained kill rate of 90 percent caused optimism. There was more good news from the inspectors: the Dexter elm was found to be free of all gypsy moth activity. Forbush wrote that the moths had been almost eradicated from the outer towns, and that even in areas where burlaps were attended only once a week, the moths had been "considerably reduced in number."[20] Fernald, whose mind had yet to settle on one side of the extermination question or the other, was satisfied on the whole with the work: "It has been a greater surprise to me than to anyone else, perhaps, to see what has been accomplished from the first; for few persons, if any, have followed and watched the work more closely than I have been able to do from the time the presence of the insects was reported. Only those who have carefully and frequently inspected the work can fully realize how much has been accomplished."[21]

The caterpillar swarms were still impressive, but many citizens noticed that the outbreaks seemed less severe. The year's work had produced an excellent overall showing for the forces of Massachusetts, and the gains for the gypsy moth seemed small compared to its losses. This was not an outbreak year, moth populations were holding steady or diminishing, and the committee was relieved to find that even in the towns and woodlands where little work had been done, conditions seemed to be better than they were the year before.

The respect the economic entomologists desired also seemed to be close at hand as a result of the eradication campaign. Mrs. Alice Ward Bailey, writing under the name A. B. Ward, was a frequent contributor to period magazines such as *Scribner's*, *Harper's*, and the *Atlantic Monthly*. After interviewing Fernald at the experiment station at Amherst and listening to his glowing review of the year's campaign, Ward enthused in print that the gypsy moths

had been dealt a resounding defeat: "What could have been a national disaster has in all probability been averted. The gypsies will soon be forgotten."[22] Further, the Commonwealth, planning for the World's Columbian Exposition to be held in Chicago during 1893, was seeking exhibits of agricultural work that would "reflect the most credit upon the State." Through the efforts of Francis Appleton, the gypsy moth committee prepared a special display case for shipment to Chicago. The Massachusetts Board of World's Fair Managers called the gypsy moth work "important" and had no doubt that the lessons taught by the display would be valuable to scientists elsewhere.[23]

As the summer turned into fall, the committee felt more relaxed than it had in some time, so its members were unprepared when Fernald's letter of resignation, dated October 19, arrived at the Board of Agriculture office in Boston. Fernald remained disgruntled with his circumstances in Amherst and was still hoping to fill the vacancy at Harvard caused by Hagen's death. Sessions was in Chicago at the time, and it was not until October 27 that Fernald's letter came to his attention. Sessions wrote to Fernald promising to bring the matter before the committee when it next met, on October 31.[24] At the meeting, a motion was made by Shaler and approved "that the Committee ask Prof. Fernald to reconsider his resignation."[25] Shaler himself wrote to Fernald the next day, adding his personal request for Fernald's continued help and offering a bit of friendly advice: "Permit me to suggest that my own experience shows that a head-worker often becomes discouraged and is apt to take an over-gloomy view of the situation. Every now and then I come to the conclusion that the world is intolerable, but after a week or two the sun gets up again, and I breathe more easily. I am always threatening to resign, but while the process has gone on for thirty years, the deed becomes year by year more unlikely."[26]

On November 13, Fernald wrote Shaler that he was now disposed to go cautiously in regard to abandoning his association with the gypsy moth work and asked Shaler to support his application to Harvard. Shaler revealed that Hagen's situation in Cambridge had never been what it seemed—his meager salary was maintained by gifts from his friends—but promised to support Fernald: "It would be a capital arrangement to have you here, for we should obtain some good teaching and bring you directly into the gypsy moth work, where you would always be on hand for effective control. I shall present these points to Mr. [Alexander] Agassiz in a vigorous way."[27]

Forbush's Army II

The policies of Massachusetts with respect to state employees were changed in 1893 to prohibit the hiring of anyone who was not a citizen of the United

States and a legal resident of the Commonwealth. After the financial collapse of 1893, the economic status of New England was so severely depressed that from 20 to 30 percent of the labor force was looking for work. This pool of potential applicants was English-speaking, so Forbush's supposed difficulties of increasing his field force are puzzling, especially since the state was paying even the newest workers excellent wages for unskilled labor. Forbush thought of his army as being divided into two unequal parts. The larger part comprised new hires and men with the least experience; the smaller part, old hands with the most experience. The committee had kept the force small during the year so it could save a substantial portion of the appropriation of 1893 to keep the most experienced men employed as scouts through the winter.

The trend toward the military model for field personnel was reflected in the adjustments Forbush made to his army this year. Members of the force were required to provide themselves with a uniform of light colored jacket and pants. The application of spray disturbed the larvae, which dropped from the leaves and could fall unnoticed on the workers' clothing, hitch a ride, and drop off at a distance to form new colonies; the light-colored cloth made the dark-colored larvae easier for other workers to see.

Visiting Entomologists I

On May 31, 1893, the gypsy moth committee had authorized Fernald to invite "not more than six entomologists from neighboring states to come and inspect the work."[28] Fernald proceeded in haste, and the visitors were on the scene within two weeks. Fernald carried out the wishes of the committee with one slight exception—instead of inviting entomologists, he invited economic entomologists, almost none of whom could be called unbiased or objective. Among the five who accepted the invitation was Dr. Joseph Albert Lintner, state entomologist of New York, a forceful advocate of chemical insect slaughter; he had once written: "Continue then to pray with fervor, as often as you join in the Church's solemn litany, 'We beseech thee, good Lord, to give and preserve to our use the kindly fruits of the earth, that in due time we may enjoy them,' but do not fail to supplement your prayer with the force pump and London purple."[29] The other four were Clarence M. Weed of the New Hampshire State Agricultural College at Durham and a founding member of the American Association of Economic Entomologists; John B. Smith of New Jersey, who taught economic entomology at Rutgers, a well-known advocate of insect extermination; Fernald's son, Henry Torsey Fernald; and Alpheus Spring Packard, presumed to be an economic entomologist because of his critical work on Riley's Rocky Mountain Locust Commission. Most of these

men were unprepared for what they saw and could make few suggestions because the scope of the endeavor was unprecedented in entomological history. They were impressed with Edward Forbush and amazed at the storehouse, with its complement of spraying apparatus. One called the building an "arsenal," and Fernald later remarked with pride that "the whole work was a revelation to them."[30]

Given the efforts of the workers and a decline in the moth population for 1893, the results for the season were impressive, convincing many of the supposedly doubtful entomologists such as Joseph Lintner that the great experiment could be a success. As he wrote to Fernald: "It was a surprise to me that in the brief space of three years the fearful ravages of the insect as described to me and as pictured in photographs could have been reduced to such comparative harmlessness . . . and that in the ride of an entire day through several of the infested towns, including a visit to localities which had been frightfully scourged, not a single example of the caterpillar was found by me, although a diligent search for it was made."[31] Since Lintner was the entomologist outside Massachusetts most familiar with the work, however (he had been a recipient of all the annual reports),[32] his professed surprise must be taken with a grain of salt. In fact, Lintner never saw the ravages of the moth personally but admittedly based his conclusions on what he had been told by others and on photographs he had been shown.

The New Jersey state entomologist, Professor J. B. Smith of Rutgers, was also convinced that extermination lay within reach: "I was, I think I can truly say, free from actual prejudice, yet with a disposition to believe . . . that actual extermination was impossible, an impression to which I had given public expression. I am pleased to say that I have seen ample evidence to induce a change of opinion, and my belief is now that if the committee is as well supported as it deserves to be it will accomplish the end for which it was created."[33] Likewise, Fernald's son, H. T. Fernald of Pennsylvania State College, was not unexpectedly impressed by the results of his father's work: "I felt some doubt as to whether it was possible to exterminate the gypsy moth, as I had some previous knowledge of it and of its ravages in Massachusetts. . . . Since my visit a careful consideration of the methods used and of the results already obtained has convinced me that extermination is not only probable, but certain, if the work can be prosecuted for a sufficient length of time."[34]

The inclusion among the visitors of Alpheus Spring Packard, then living and working in Providence, Rhode Island, is a bit surprising because in later years he became an influential opponent of insect extermination. Nor was he impressed by what he saw in eastern Massachusetts but seemed to believe that if he had nothing good to say, his report should at least give no offense: "In

the short time I spent I saw nothing to find fault with, but much to commend. I say this without wishing to merely say something pleasant, but because I mean it."[35]

Fernald and the leadership of the gypsy moth work would not give the time of day to any man who expressed a negative opinion about the work without having seen the killing fields in person. They had an unshakable belief that scientists and thinkers of their day would be impressed by looking at bushels of severed caterpillars, grassy fields remarkable only for their lack of diverse life, or gangs of exhausted men chopping down the forest. They seemed oblivious to the notion that there was nothing scientific about their undertaking. The matter of successful fieldwork was one of good organization, the maintenance of schedule and discipline, fair weather, and good luck.

At about this time, Sessions received a letter from Ellwood Cooper of Santa Barbara, California, who had written to encourage the use of parasites. Cooper, who eventually became the California state commissioner of horticulture, mentioned a European parasite he thought would be useful in both California and Massachusetts and inquired whether the committee would share expenses to import the insect in quantity. Fernald rejected the idea out of hand. Sessions was not much taken with the plan, either, as he wrote to Fernald: "I am of course aware that nothing of the kind can be undertaken at present. Our appropriation is for extermination as well as for preventing the spread of the [gypsy moth]. This gentleman speaks as 'from the book' saying 'no insect pest can be totally destroyed.' We are trying to prove the contrary."[36]

The year ended with the Board of Agriculture forming a subcommittee under F. H. Appleton to appeal for help from the federal government and the U.S. Department of Agriculture. The chances of success were very slim, since Agriculture Secretary Julius S. Morton held on principle that there should be no federal interference in matters concerning individual states. Riley, with evident pleasure, noted:

> The thing that strikes me as curious, however, is that, according to the report by Professors Smith, Lintner, etc., who were invited by the Gypsy Moth committee to inspect the work last summer, the work has been very satisfactory. I cannot reconcile this with the appeal now made for federal aid. It looks to me very much as if my advice and the position I took on the question are being thoroughly justified and vindicated and that the committee will come to regret that it did not follow my advice.[37]

[CHAPTER 10]

Rebounds and Resignations (1894)

FORBUSH WAS DETERMINED not to let the moth escape the boundary of 1891. He knew it was easy to overlook the insect and feared that moth colonies established outside the boundary would reinfest areas that had been cleared. The committee had hoarded nearly $30,000 into the new year, and eighty-three men worked through the early months of 1894 making another inspection of the region. Three previously unknown colonies discovered outside the boundary of 1891 and a colony in Boston's Franklin Park proved to be at least four or five years old while places like the Middlesex Fells showed increased moth populations. Forbush sent inspectors great distances, even to towns and villages in neighboring states. He ordered several inspections made following his practice of repeating passes through suspect regions.

Forbush considered these inspections so crucial that he took men from work even during the swarms and sent them out to scout, weakening his effort and draining the financial resources of the committee. This practice was a source of intense dissatisfaction in the central districts, whose residents could not understand why men were taken from places where the caterpillars were abundant and sent to work in places where they were scarce. Egg masses that engulfed the trees in the central districts were left untouched while skilled men searched for one or two in places where they could hardly be found, leaving the abandoned communities to form and pay for their own gypsy moth gangs.

Some, such as the perennially pro-extermination J. O. Goodwin, accepted the responsibility as a personal one. Goodwin banded his trees and hired men to work for several weeks at the height of infestations. At times the caterpillars came in such overwhelming numbers that Goodwin could not keep up with them. His men were using a large stove containing a hot fire to incinerate the larvae, but they heaped in so many insects that the fire would be extinguished before the day was half over.[1]

In February 1894 the Board of Agriculture reorganized the committee, gave

it new responsibilities, changed its name to "the committee on gypsy moths, insects and birds," and increased its size from five to six members. The sixth member was the board's secretary, a member ex officio of all committees. The gypsy moth committee became one of eight standing committees, and its members included Chairman E. W. Wood, Francis H. Appleton, William H. Bowker, Augustus Pratt, and F. W. Sargent. Revised bylaws required the board to hire six specialists, including an entomologist and an ornithologist, as advisers. The specialists were required to attend the board's annual meetings at their own expense.[2]

Restive members of the state legislature demanded to know what the outcome of the extermination effort was likely to be and how much more money it would cost over a period of ten years should extermination fail. At legislative hearings in February 1894, the committee promised that within a few years at least twenty-four of the thirty-three infested communities would be free of the moth, though admitting that eight thousand "estates" probably would remain infested. The costs of extermination on these estates could run as high as $328,000, in addition to the $100,000 it would take each year to prevent reinfestation of cleared areas.

Residents of the infested areas testified to the destructiveness of the insect, many of them a little too obviously at the behest of the Board of Agriculture, telling the legislators that combatting the pests individually did not work. Former senator Low described seeing the walls of houses and nearly all the trees covered with egg nests. J. O. Goodwin was by now so paranoid about the moth that he claimed they would "kill every living thing on the face of the earth if they are not destroyed."[3] The finance committee, however, announced that it would reduce the appropriation request by 40 percent, and the moth committee once more blamed the influence of misguided public opposition for the reduction.

Francis H. Appleton resigned in protest, stating that without sufficient funds it would be impossible to accomplish the task the committee had been charged to do. He was likely uneasy with the path of events because the committeemen seldom visited the field and relied too heavily for advice on Forbush, Fernald, and their associates. Appleton, who lived in the heart of the infested district, observed, "The general public by and large was not interested in the work."[4] Nathaniel Shaler also resigned his position early in 1894, claiming ill health and the press of other obligations. Charles Fernald requested that he, too, be relieved of his duties, citing the negative effects on his academic obligations and research work of the gypsy moth committee's demands—although he later said he had become discouraged over the lack of progress in the field and the constant reductions in appropriations.[5] There is evidence that

Edward Forbush tried to relinquish his work at this time as well but that the beleaguered committee refused to consider his request. Forbush's departure would have been serious enough at any time, but losing him along with Fernald would have been a catastrophe. The pool of potential replacements was painfully small, and by the time other men could be found, the entire field force might have collapsed from lack of leadership.

The executive committee of the Board of Agriculture implored all these men to reconsider. The work of the gypsy moth committee had quickly made it the most important standing committee, but there were no other board members available to fill their positions.[6] Appleton was insistent, however, and at the meeting of July 26, 1894, the board relented. John B. May wrote that Forbush tried to resign twice but that the committee would not accept his resignation.[7] Although the exact date Forbush tendered his resignation is not known, the situation at this juncture and the actions of other members of the gypsy moth leadership group strongly suggest that Forbush's attempt to dissociate himself from gypsy moth work occurred at this time.

The resignation of four key members of the gypsy moth campaign had no effect on the legislature at all. Fernald and Forbush were coaxed back into their critical roles. Although Appleton and Shaler went on to other things, neither would be free of the gypsy moth for many years. The gypsy moth committee immediately petitioned for an additional appropriation of $65,000 and again asked that an independent panel review their work. Neither request was granted.

The Aliens Advance

The committee's funds were expended by May 1, and fieldwork ceased until May 23 when the legislature voted an appropriation of $100,000. The hatch occurred during this hiatus, and a frustrated Forbush could only watch as the trees pullulated with larvae beyond counting. The workforce was reassembled as quickly as possible and the new men sent into the field as fast as they could be trained. The reports they sent back to headquarters were completely unexpected, darkly foreboding, and deeply troubling: the gypsy moths were everywhere, swarming by the tens of millions and overwhelming the fieldworkers with their vast numbers.

The effect of this news was devastating. The most careful and costly inspection of the campaign, just completed, had indicated a war going so well that Forbush had reduced the size of his army. Yet somehow, either vast numbers of egg masses had been overlooked or the fecundity of the moths had increased beyond even the wildest expectations. Since Fernald and Forbush had not

anticipated a large population rebound, no strategies for this contingency were in place; there were too few men available to respond, and there was not enough money to hire enough additional employees.

Over 624,000 trees were banded, and an undersize army of 250 men was sent to attend them. A desperate effort was begun to cut as many trees as possible in areas where the caterpillars swarmed most densely. Implementing this practice required an immediate infusion of new employees, but it also allowed Forbush to relax his employment standards. Men did not need much training to chop down a tree, and tying burlaps required only diligence rather than expertise.[8] Spraying rose to the highest levels since the campaign began; nearly 15,000 individual trees were treated, almost three times the number treated the previous year. But records of larvae killed by spraying were impossible to compile. Although millions were poisoned, the slaughter barely made a difference. The tally at season's end showed that 1,153,560 caterpillars were killed by hand, all taken under burlaps.

Fernald and his assistants devised a plan in which laboratory-raised females were placed in cages surrounded by sticky paper to which the luckless males adhered when they sought the females. Thousands of moths were thus destroyed, the idea being that if enough males could be removed from an area the females would lay sterile eggs. The experiment was abandoned when even the females in the traps were fertilized, and many of the surviving males were seen to mate with at least four wild females.[9] After the female moths had laid their eggs, the committee's employees trimmed more than eight thousand trees, cut down some six thousand more, and burned ten thousand acres of brush and woodland.

Forbush began discharging men early in August and continued through the fall until only 133 were left, even though he was desperate to undertake another complete scouting to discover why the increase of larvae had occurred. He also needed to investigate the next belt of towns surrounding the boundary of 1891 to see whether the gypsy moths had broken through the lines, but the area was so large that the commanders once again decided to abandon all efforts in the central infested towns and concentrate on places that had never been inspected. It was crucial that the moths remain contained. If they slipped past the boundaries, and if the hatch next spring were as large as the one that had just taken place, the war would be decisively lost.

The residents of the central districts again watched in dismay as the forces of the state left them to their own devices. Walter Wright complained that scouting was a waste of time and money, saying that only a little inspection would suffice to show the presence of the insect and give an idea of its numbers. Wright told Forbush that the work as presently done was like a fire department that responded to a single call by soaking the entire community.[10]

Oliver J. McCarthy, a six-year veteran who had participated in a number of "scouts," considered scouting to be worthless:

> [We sprayed] on the outside of the Lexington Valley colony in 1894, where there were no moths, leaving the center of the colony untouched, where there were lots of them. [We scouted] the road sides in Lexington in 1893 and 1894 and leaving the woodland go where there were large colonies of the moth. Why, we have been up there and banged around the road sides in Lexington and had a good time with different inspectors, drank hard cider, etc., never got a bug. Half a mile beyond there was millions of them.[11]

In the fall, destruction of egg masses resumed. Leland Howard observed the egg hunters at work and was impressed by their skill: "The eggs must be searched for in inconceivable crevices, trees must be climbed, and egg clusters, which cannot be reached by hand, must still be painted by means of brushes attached to the extremities of long poles. The process, however, is carried on very effectively and much more rapidly than would be supposed."[12]

Inspections showed that the moth was continuing its spread into the Boston districts of Roxbury and Dorchester, and colonies were found within the city itself. The area infested by the moth thus increased to 220 square miles, although the committee felt that for the most part the boundary of 1891 remained intact. While the situation in some of the treated towns improved, the number of colonies in the Lynnfield woods and similar places was rising. The practice of concentrating on the outer towns left at least sixteen separate interior wooded areas as sanctuaries for the moths. Forbush noted that scattered colonies existed in woodlands from Lexington to the sea and from East Lexington to Salem in a belt a mile wide. The insects were entrenched in a fifty-square-mile block in the heart of the boundary where the committee estimated that 12,000 acres were infested, and attending to these areas would require work on no less than five million trees. To ensure that the moth had not infiltrated farther inland, much of the winter inspection work again was done in towns and villages outside the boundary, an area much larger than the containment zone, and searches were made at a great cost in time and money. In some years these inspections constituted the committee's single largest expenditure and became a source of contention with the legislature, which felt that appropriations for moth extermination should be spent on exterminating moths, not on traipsing through the woods in the middle of the state with pads and pencils.

The mood of the gypsy moth fighters was much different at the end of 1894 than it had been the year before, when victory seemed within easy reach. It

was becoming a tricky matter to claim on the one hand that the infested territory had been reduced by half while reporting on the other that new colonies were being found outside the boundary with every inspection. The moths expanded their range southward into Boston and reappeared in places from which the committee thought they had been cleared. The experiments with lead arsenate had showed that even its greater potency could not exterminate the moths. It was increasingly difficult to recruit and retain competent fieldworkers. Public opinion about the gypsy moth work remained unfavorable; there was a strong likelihood that the General Court was going to reduce appropriations to the point of uselessness; and the support of fellow entomologists seemed to be wavering.

Fernald, in two states of mind about the work and his part in it, wrote in his report for 1894 that he had visited the infested regions often and inspected the work carefully. In a guarded way, he said that everything had been done that could be done with the money available, and that the fieldwork had been thorough and carried out along approved lines.[13] If the extermination program showed any sign of failing, it was due to the stinginess of the last two legislatures, and the blame must be put where it belonged. The General Court, by chapter 71, Resolves of 1894, authorized the gypsy moth committee to prepare the most detailed and comprehensive account yet issued of the progress in the war against the gypsy moth and its likely outcome, and to elaborate on "the scientific facts ascertained." The committee was directed to present the report to the next legislature at the beginning of January 1896.

Visiting Entomologists II

The gypsy moth committee was heartened by the response of the entomologists who had visited the work zone in 1893, and the committeemen began to see that the value of these visits was more than just scientific. As Sessions noted in a letter to Fernald, they could also favorably influence public opinion.[14] Fernald again solicited comments from the few men who, he believed, represented the best that economic entomology had to offer. Leland Howard said that in 1894 there were probably, by this standard of judgment, fewer than thirty qualified entomologists in the entire United States.[15]

Most of the men who accepted the invitation, and on whose opinion so much emphasis was placed, had never seen living gypsy moths, let alone swarming colonies defoliating trees, which most of them still had not seen when they left. They were shown instead areas that the field force claimed to have cleared in previous years, and they viewed unremarkable land or grassy meadows that had once contained young forests. Many of the visitors spent

just a single day making cursory inspections. Two did not arrive until mid-July, when the insects were pupating. Vermont entomologist George H. Perkins remarked that some of the worst defoliation he saw was caused by canker worms.[16] The entomologists' visits were arranged to make the best possible impression on them. Workers were notified in advance to be busy when the distinguished guests were driven by. Private I. J. Colbert recalled that nobody of importance was ever brought into the field that the workers did not know about in advance, and the workers were told to be laboring assiduously when the guests appeared. Colbert said this was standard policy; that visitors always saw the work under the most favorable conditions, he thought, "account[ed] largely for the favorable opinions that we hear from time to time."[17]

Among some of the more far-seeing practitioners, the question was not whether the insect could be exterminated but whether it *should* be. They asked whether the present undertaking required so much effort and money that it could not be sustained, and whether it would be better to follow the European practice of controlling the insect only where it became a nuisance. John Henry Comstock of Cornell University, former chief in entomology at the U.S. Department of Agriculture, sounded a call for reassessment: "I have come to have grave doubts as to the advisability of attempting to exterminate this pest. I am not prepared to say that I consider extermination impossible, but it seems to me that the attainment of this desired end is highly improbable."[18] Comstock was doing his best to support a fellow entomologist in a difficult situation, but he knew it was not just that the possibility of extermination was questionable, but also the idea that the state would continue to provide funding for any extended period: "[If] the Legislature appropriates less than two-thirds of the sum [deemed necessary], it is hardly probable that succeeding Legislatures would furnish the means necessary to carry this work to its conclusion. . . . I respectfully suggest that you consider the advisability of adopting a different method of combatting the pest."[19] In short, Comstock's report made several almost heretical recommendations: first, that the scope of the effort was too narrow and should be broadened; second that the use of natural adversaries and parasites would eventually bring the moths under control; and third, that the rejected approach of the California Board of Horticulture should serve as a model for the campaign.

Professor F. L. Harvey of Maine State College at Orono, though impressed by the work in progress and the triumph that seemed to lie so near, saw the Achilles heel of the undertaking: "The present number of men employed seems to me to be inadequate, as large areas of the infested district have to be neglected while inspection is going on in others. Unless a large force can be kept constantly employed for some years, the idea of extermination will have to be

abandoned."[20] Harvey thought the idea of holding back such a powerful natural force by handpicking, poisoning, and burning larvae was problematic at best. He let slip the third agenda of the campaign when he noted his hope that the gypsy moth committee would settle the issue not for the good of the Commonwealth but "for the good of economic entomology," and that every state would have an entomological commission "with duties as broad as the requirements of economic entomology."[21]

Harvey also told Fernald that he had learned of some naturalists who were breeding gypsy moths outside of Massachusetts.[22] Harvey did not mention any names, but J. A. Lintner, state entomologist of New York, had obtained egg clusters shortly after the publication of Fernald's first danger bulletin and, as he later claimed, before the laws of Massachusetts prohibited distribution of the insect. Wanting some specimens for his personal collection, he had taken the eggs to his office on the top floor of the capitol building in Albany, New York, where he raised the larvae to maturity. The caterpillars pupated and were about to emerge at the time Lintner was leaving for his vacation in Keene Valley, New York, so he took the pupae with him because he did not trust his assistant to keep the moths from escaping. As the moths emerged, Lintner killed them one by one and mounted them, labeling the location as "Keene Valley, New York."[23]

A few years later, when an inspector from Forbush's office was in Lynn, Massachusetts, at the house of an amateur entomologist, he spotted one of the labeled specimens with alarm. The rumor that gypsy moths were in New York sent Fernald running for the train to Albany for a conference with Lintner, but upon his arrival he received a confession instead. Fernald could scarcely upbraid his reckless friend, because he himself had taken gypsy moths to Amherst, far west of the infested zone, so that he could experiment on them conveniently in his own laboratory. Lintner was a staunch ally and a respected official entomologist who took a splendid view of the work in the Bay State; he wrote that he considered "this effort being made now in Massachusetts as one of the greatest undertakings in modern science."[24] He was also an unmitigated hawk on the issue of destroying the insects: "It is a wise saying, if construed aright, that 'Providence is ever on the side of the heaviest artillery.' Fight the insect as you never have before, and do not sound an inglorious retreat or yield a pitiable surrender, just as the instruments of warfare and the insecticidal ammunition with which you may wage effectual fight, have been placed within your reach."[25]

Leland Howard, the newly appointed successor to C. V. Riley as chief in entomology at the U.S. Department of Agriculture, believed, to the contrary, that the war was meaningless and proposed the almost unthinkable course of taking no further action at all:

> If the appropriation were taken away the insect will not only speedily reach its former destructive height, but will spread far and wide over the country. It may be urged that it will only be a few years before the insect will take its place as a naturalized member of our fauna, and will become subject to the same variations of increase and decrease as our native species, and that it will, in fact, become little more to be feared than species already existing with us, particularly if its natural European enemies are introduced.[26]

Howard had the curious ability to belong firmly to one camp or the other or, often, to both at once. The gypsy moth might be exterminated, it might be suppressed, or a running fight with it over the entire East Coast might go on for a hundred years; it didn't really matter to him as long as economic entomologists were in control. Howard knew that the Massachusetts experiment was in deep trouble, but his typical response was to present an unfailingly cheerful outlook, no matter what the reality of the situation might be: "The work upon the gypsy moth . . . is one of the most remarkable pieces of work, judging from the results, which has yet been done in economic entomology. . . . The infested territory has been reduced by one-half, and within the districts within which the gypsy moth at present exists it is, practically speaking, a comparatively rare insect."[27]

The visiting entomologists were often amazed not just that the work was taking place but that the Massachusetts legislature continued to vote relatively large appropriations. Fernald recalled that some could hardly believe the work was still going on:

> Dr. Howard and Professor Comstock of Cornell University were here with me at one time and we went over the territory, and we would go back to the hotel and sit down in the evening in my room and talk it over. . . . Professor Comstock said, "New York would never have appropriated so much money as would be necessary to exterminate [the gypsy moth]." Dr. Howard said, "I don't know of a state in the Union that would appropriate so much money as this." They knew that I was from Maine formerly and they said, "Would Maine do it?" I said, "No."[28]

Without adequate funds the entire initiative would collapse, and this point was impressed on the visiting experts. The question of allocations was not one that could be determined from inspecting the field, so no doubt it was discreetly suggested to the visitors that their observations include the need for continued funding. Almost all their reports did so—a uniformity that strikes

one as less than coincidental. The future of economic entomology would be decided in the next few years, and it would likely have no future if there were no jobs for the men that were coming from schools like Fernald's. Fernald made all his students take the examination for the field force, and Forbush was always happy to hire those who passed. A number of young, college-trained entomologists started their careers by working for the gypsy moth committee at the rank of inspector or as a member of the experimental squad, their salaries paid by the Commonwealth of Massachusetts.

The Metropolitan Park Commission II

The Board of Agriculture and its gypsy moth committee had to deal with the single-minded board of the Metropolitan Park Commission to work out an arrangement for insect control in the Middlesex Fells and other reservations. Both boards were driven by the particular urgencies of their situation and mandate, and both considered their work to be of commanding importance. The entomologists and agriculturists thought of the extermination attempt as representing the greatest experiment of its type in the history of science. Everyone in the MPC felt the same about park work, as typified by the comments of the commission's senior landscape architect, Frederick Law Olmsted: "Nothing compares in importance to us with the Boston work, meaning the Metropolitan quite equally with the city work. The two together will be the most important work in our profession now in hand anywhere in the world."[29]

Any association of these two strong-willed and zealous boards was bound to be an uneasy one at best. The committeemen and the commissioners had held a series of meetings beginning on March 6, 1894, and it is evident from the few surviving letters that the gypsy moth committee emerged somewhat hobbled by the park commissioners, who would allow only work not in "conflict with the plans of the park commission."[30] Forbush became subservient to the various superintendents of parks in which he wanted to work. His men were to wear a badge while in the parks; trees could not be cut down until they had been inspected and tagged; and infested trees were to be burned only with the consent of the park superintendent.[31]

The MPC was engrossed in the early stages of its task, and gypsy moths were not high on its list of priorities because the park commissioners believed that none of the reservations was seriously infested. Their landscape architects were more aware of the insect's potential for destroying thousands of dollars' worth of new plantings as well as ancient and irreplaceable trees. They mentioned in their 1894 report that, "this voracious creature . . . must be fought as zealously as fire if the trees are to be saved alive."[32]

The park commissioners at first were relatively amenable to the gypsy moth committee because moth work was advantageous to both parties. The removal of dead and dying trees served the purposes of the gypsy moth committee by reducing the number of breeding places that would otherwise require treatment on an annual basis; the park commissioners saw it as a way to improve the chances of struggling young seedlings and to reduce the threat of fire. Thereafter, however, the interests of the two groups diverged: the park commissioners wanted the clearing done once, whereas the gypsy moth committee argued that the grounds would have to be cleaned and burned twice each year until the gypsy moth was gone.

The differences between the two groups were widened by the state's Boulevard Act of 1894, Chapter 228, which authorized the MPC to create thoroughfares in district reservations and connect them with streets and electric rail lines from the cities of Boston, Malden, and others. Legislation to link the parks and reservations had been strongly pushed by the MPC. The act was signed into law by Governor Russell partly to further the work of the metropolitan parks and partly because the state was in recession after the financial collapse of 1893, and road building created jobs for the unemployed.[33] The last thing the gypsy moth committee wanted through the wooded regions was a network of roads that would provide unparalleled opportunities for the dispersal of the gypsy moth during its larval stage, and nothing within reason could prevent it.

Intelligent Spraying

Riley always contended that spraying had to be done intelligently to be successful; the ultimate achievement mostly depended on the skill and experience of the man at the end of the hose. The goal of the nozzle man was to float a fog of insecticide on the foliage, watching as the liquid built up. At the moment when the leaves became wet, the suspension became visible as a white coating, at which point the spraying had to cease or the water would run off the leaves, taking the arsenic with it. If all were done well, an even coating of poison would remain on the leaves after the water evaporated.

After a tree or a small cluster of trees had been sprayed, the entire apparatus had to be moved. Fragile, fabric-wrapped rubber hoses had to be rolled up and returned to the wagons. The tanks required frequent refilling, which meant driving to the nearest source of water (although sometimes a water wagon stood by). At a hydrant, the tank could be filled easily, but water from streams or wells had to be pumped by hand. Once the tank was refilled, a new batch of poisons had to be mixed, allowed to precipitate out, and then be agitated, after which the wagon had to be driven back to the work area

and its hoses and nozzles recoupled for use. A typical wagon was spraying only half of the time it was in the field, and that much only if nothing malfunctioned.

Lead arsenate did not kill as fast as the older varieties of poison, and some time passed before Forbush and Fernald realized that the proportion of 5 pounds to 150 gallons of water was too low. The concentration was doubled to 10 pounds per 150 gallons, and subsequently tripled to 15 pounds before even a modest effect was noticed. Moreover, lead arsenate was most effective when used early in the season, but the committee could not count on spring spraying because of frequent budget delays and rainy weather. One crew mixed 40 pounds to 150 gallons of water and reported that after spraying, the caterpillars vanished, but Forbush realized that the continued use of heavy concentrations was out of the question: "Although [lead arsenate] is the most effective poison yet used on the gypsy moth caterpillars, doubtless it would have failed, like Paris green, to check their ravages when they were in full force. After four years of experimenting I am constrained to believe that no form of arsenic, unless used in unsafe quantities, can be relied on to hold the gypsy moth in check, much less to exterminate it."[34]

For several years no one in authority seemed to know what to do with this dangerous substance. The committee used the material sparingly because it was expensive, unreliable, and highly toxic to honey bees. It was effective against a wide range of other insects, however, and once word of its efficacy got out, the committee's reluctance to apply the chemical was not shared by others. In less than ten years the use of this poison swept across the country from East Coast to West. Fernald encouraged the widespread use of lead arsenate because he felt it showed the value of economic entomology and reflected well on his profession and the progressive nature of the Commonwealth. Economic entomologists, farmers, and fruit growers hailed the discovery as a boon to agriculture, and the gypsy moth committee and the Massachusetts Board of Agriculture claimed it as their great gift to humanity. By the end of the first campaign this chemical was being produced by many New England companies, including Bowker Chemical in Boston, Swift & Co. in Boston, and Merrimack Chemical in North Woburn. The toxic wastes produced by unrestricted production still pollute part of the greater Boston water supply.

To Kill a Gypsy Moth

Forbush and Fernald were gripped by a compelling need to discover why it took so much arsenic to kill a gypsy moth caterpillar and how many gypsy moths would have to be killed each season to keep their populations from

increasing. During the summer of 1894, gypsy moth larvae were fed controlled amounts of arsenic and then dissected by A. H. Kirkland at the Hatch Experiment Station in Amherst, after which F. C. Moulton analyzed their organs and tissues in the Harvard chemistry lab. The insect had a remarkable capacity for excreting most of the arsenic it ingested and tolerating whatever was left; it could withstand more than twelve times the fatal proportional dose for an adult human being. Living insects were found to contain large amounts of the poison, which did them no harm and remained with them through their pupal stage. Measurable quantities of arsenic could also be found in the imago, though the vitality of the insect and its reproductive functions were hardly affected. Fernald put it succinctly when he said that after the larvae were more than a few weeks old, they were able to eat Paris green and "grow fat."[35] He told his colleagues: "I took some of the insects home and fed a large number of them, and I could not believe my own results and had my assistants try it again. I had tried it in the field, and I tried it three years in succession myself, and I am obliged to say that you can not kill this insect with Paris green unless you use more than it is possible to put on the trees without destroying the foliage."[36]

During a series of experiments with other poisons, Moulton fed a strychnine-covered piece of lettuce to a caterpillar. After about an hour the caterpillar stopped moving and appeared to be dead. When Moulton looked an hour later he saw the caterpillar was alive and had resumed eating the poisoned leaf. After the second feeding, the stunned caterpillar rolled over on its back and apparently died again. When Moulton visited the cage after several hours it was his turn to be stunned—the caterpillar had revived once more and appeared to be normal.[37] Although the gypsy moth did not have the nine lives of a cat, it demonstrably had at least three.

Both Forbush and Fernald originally miscalculated the potential for the moth's annual increase and were unprepared for large hatches of larvae. They could not understand how population explosions occurred after exhaustive scouting indicated a great decline in the moth's numbers. Although the scouts could not count single caterpillars, it was possible to count individual egg clusters, a method adopted after it became the practice to destroy egg masses with creosote and leave them in place. By counting the fresh egg clusters within the known limits of a colony, and comparing that number with the egg clusters of the same colony from the previous year, a determination of increasing populations could be made: "The ratio of the average annual increase of ten such colonies was found to be 6.42—that is, six or seven egg clusters on an average may be found in the second season to one in the first season."[38]

A surviving caterpillar reproduces, and the capability of the moth in this respect was unbelievable. If only one male and one female from the same

cluster survived, they could produce enough larvae to ensure that the population remained the same the following year; moth populations retained their density after suffering losses of 99.6 percent. A survival rate that produced even one more female allowed the moth population to double, and if just four gravid females survived, the total hatch of larvae the following spring could be four times the number of insects produced the year before.

Observation and work in the laboratory during the early outbreaks showed that most egg masses contained up to 600 eggs, but Fernald estimated the average at a very conservative 500 eggs per cluster, and by the end of work for 1891, Forbush was using 468 as the average number.[39] Fernald concluded that destroying six of every seven egg clusters each season would eliminate 85 percent of the insects before they hatched, and given another seven or eight percent reduction based on the destruction of the insect during other stages of its life, he believed that population increases would be checked. Ten colonies were selected and their egg masses counted. The data extrapolated from these few colonies then served as a model for almost the entire duration of the campaign. Massive outbreaks occurred because the scouts were unable to make an accurate count of the number of fresh egg clusters, because the assumed number of eggs in each cluster was off the mark, and because the directors had underestimated the percentage of eggs that would have to be destroyed in order to cancel the moth's gains.

Fernald believed the magic number needed to hold the gypsy moth population steady was 90 percent elimination. The terms "90 percent," "nine out of ten," "nine-tenths," or their inverse—"10 percent," or "one in ten"—appeared often in the annual reports of the committee. For example, at the close of fieldwork for 1891, Forbush reported that a 90 percent reduction was sufficient to hold the moth populations steady: "The spraying and other treatment of the trees redoubled the fruit crop of the district. The measures used disposed of the annual increase of the moth, and *reduced the numbers originally found by about ninety percent*" (emphasis added). Forbush repeated this percentage in his annual report for 1892 and reaffirmed his belief that the committee's work had kept the moth populations from increasing: "Nine tenths of the moths in the region found infested had been destroyed, and there was no immediate danger from them *as long as they were kept under control*" (emphasis added).[40]

[CHAPTER 11]

Unusual Business (1895)

The state legislature asked Massachusetts senators and representatives in the U.S. Congress to request $100,000 to assist in the fight against the gypsy moth. In early January 1895, Francis Appleton, once again drawn into the war, joined William Sessions, William Bowker, and Edward Forbush before House and Senate committees in Washington to support legislation introduced by Massachusetts Senator William Cogswell.[1] Since Massachusetts would not allow gypsy moth appropriations to be spent outside the state, the delegation traveled at its own expense, with some help from Cogswell's office.

The visit by the Massachusetts delegation, which included a meeting at the Department of Agriculture, had been planned for late 1893 or early 1894 but had been postponed—possibly on Riley's advice that chances for success were slight, given Agriculture Secretary Morton's opposition to "federal interference in state matters"—and possibly because of the disintegrating situation in the office of entomology at the USDA.[2] The tempest concluded in 1894 when Riley, embittered by his failure to be appointed professor of entomology at Oxford and passed over for the post of assistant secretary of agriculture, resigned, much to everyone's relief.[3] His successor, much to everyone's surprise, was his former assistant, Leland Howard, a far more complaisant man.

Cogswell introduced the Massachusetts delegation to Secretary Morton, who gave them a cordial but cautious hearing, fearful that opening the federal purse to assist in the fight against the gypsy moth would flood him with similar requests from every state in the union. The delegation reported that Morton seemed disturbed by the photographs Sessions had brought but would not give them assistance because they had "not followed the advice of Prof. Riley."[4] With Riley now out of the way, it was possible to recast his role in the gypsy moth campaign from that of a strong advocate of spraying to a champion of natural controls.

The problem for the delegation was not that they hadn't listened to Riley but that they had. They tried to explain to Morton the reasons why they had not been able to change course, but Morton was not convinced and indicated

that if the matter came before Congress, he could not support it but would offer no opposition. When Fernald learned of the events in Washington, he wrote to Herbert Osborn that he had little faith in obtaining a congressional appropriation, saying, "I am absolutely certain that we cannot get aid from Congress without [Morton's] sanction, and I do not believe we could if he should favor it."[5]

The U.S. Senate hearing on the resolve occurred on Friday, January 4, and the Massachusetts delegation also appeared the next day at a special Saturday hearing of the House Committee on Agriculture. Senator Henry Cabot Lodge, a Bostonian, amended the bill and brought it before the Senate, which resolved to appropriate $40,000 for use against the gypsy moth, but the bill died in conference. This was a double setback, because it would have been much easier to get a state appropriation if the federal government had shouldered part of the burden.

Upon the empty-handed return of the delegation, the Massachusetts Board of Agriculture requested an appropriation of $200,000 from the state for 1895, but the General Court balked. On February 11 a divided legislative committee on agriculture held public hearings that were attended by hundreds of citizens and subsequently recommended an appropriation of $150,000. The legislature was convinced that the board had asked for a large amount knowing that the request would be cut back, and the attitude of the General Court was typified by the comments of Senator Alfred E. Barker: "If I go to a man and ask him for ten dollars a few times and I get five dollars each time, I know his policy, and if, sir, I don't ask him for twenty dollars when I want ten dollars, then, sir, I am not a real smart fellow. Now, if this gypsy moth committee came up here for five years and asked for a certain amount of money, and failed to get it each time by about 50,000 dollars . . . and then did not come up and ask for more than they wanted, they are not smart enough to wipe out the gypsy moth in Massachusetts."[6]

Large numbers of furloughed gypsy moth workers attended the legislative hearings in Boston, packing the galleries and irritating the legislators, who thought the men had been sent by the gypsy moth committee to intimidate the opposition and influence the appropriation. The legislators wanted the workers removed, but Sessions argued that these men at the moment were private citizens who were not employed by the state and had the right to observe the hearings.

The committee carried over 133 men into 1895, but the large payroll soon exhausted its funds, and on February 6 the entire force was dismissed. The committee waited through February for its appropriation, and then through March, and finally through April while the state legislature attended to other

matters. During this time the committee could do nothing but make preparations and attempt what it could with a small number of volunteers.

Continued Experiments

Among other things, Fernald and his assistants at the experiment station tested the effects of temperature extremes on moth eggs. They found that the eggs could withstand temperatures of 130 degrees Fahrenheit and still hatch. Egg masses at eighty degrees were plunged into a mixture of calcium chloride and snow at twenty below zero, dropping their temperature one hundred degrees in fifteen minutes; within three weeks all the eggs hatched. Early instar larvae tolerated cold better than heat; late instar larvae tolerated heat better than cold, each case corresponding to the probable climatic condition at that phase of their lives.

Fernald also tested food preferences and identified about three hundred plants on which the caterpillars would feed; moreover, he verified that whatever a gypsy moth larva would eat, it would eat in great quantities; one female consumed a stupendous 212 square feet of leaves during her life.[7] A starving gypsy moth caterpillar will devour almost anything, including field crops, garden plants, and even turf grass. Fernald noted that some of the plants he tested came from regions hundreds of miles away from Massachusetts: "Some cotton plants were brought from the South, and we find that it is a very excellent food plant for them. They revel in it; in fact, they ate the whole thing up. If they should ever get into the South I think they would be capable of committing sad havoc there."[8]

More Moths Than Ever

It is the nature of Nature to favor first one side and then the other, but conditions in 1895 remained ideal for gypsy moths. In the warm and early spring, uncounted legions of caterpillars hatched, once more taking everybody by surprise. Forbush was desperate to start work and furious with the legislature for delaying the appropriation again. Three months of the best working weather had been lost, during which the eggs could have been destroyed with ease. He would be forced to exterminate the larvae after the hatch by spraying, which would be less effective, cost him ten times as much money, and reduce the amount of work that could be paid for later. Forbush was not going to be caught unprepared again or the gypsy moths would run riot. He recalled his best men on the first of the month and put to work those who agreed to wait for remuneration. He exceeded his authority and further strained relations

with the legislature by hiring staff for his office, purchasing supplies on unofficial credit, and interviewing candidates for positions at a time when there was no money to pay them.[9]

By the time the legislature passed an appropriation on May 17, the caterpillars had undergone their third and fourth molts. With his veteran force of 1894 scattered, Forbush scrambled to organize a response. Most of the new workers had to be trained; consequently, they were used at the tasks of lowest skill. Since it was too late to destroy eggs, the new recruits banded trees with burlap, and they cut and burned brush. The caterpillars clustered so thickly on the trees that men had to sweep them off the trunks before they could tie on the burlaps. To compensate for the ground lost during the egg season, Forbush instituted twice-daily inspections, and in some places the bands were visited even more often. The numbers of caterpillars increased, and Forbush kept hiring more men, but all the new workers had to squeeze through the administrative bottlenecks he had set in place: every man was trained to a minimum standard, and groups were formed and assigned to competent superintendents; supplies and equipment were bought and units organized. No matter how urgent the situation, Forbush would rarely let any group of men take the field until he believed they were ready.

Forbush had discovered that young Kirkland, just one year out of college, harbored a drinking problem that suddenly burst into the open. This put Forbush in an awkward position because Kirkland and Albert F. Burgess were two of Fernald's most beloved students. Matters came to a head in June when Kirkland and some other members of the force were caught in an embarrassing situation, but Forbush elected to take the high road in his letter to Fernald: "Jones was discharged for neglect of duty and confirmed habits of intoxication. I have no charges to bring against the lady you speak of. Mr. Kirkland says he has stopped drinking entirely. . . . I have promised him to say nothing about his last affair if he will stop it. So hereafter I am dumb."[10]

Although Fernald may have been disappointed in his recent graduate, he likely was not as concerned as Forbush, because he had again decided to resign. But that he had placed Kirkland first on a short list to replace him presented further difficulties for Forbush, who would in that case have to work with Kirkland as an equal—a possibility that did not bode well for either man. As Forbush wrote to Fernald: "I should much prefer not to have any further responsibility concerning [Kirkland] or the insectary, and if you decide to sever your connection with the work I shall ask the committee to relieve me of any further responsibility in that connection. . . . Knowing Kirkland as I now do I prefer to have nothing further to do with him, but if it is for the best interests of the work I am ready to do anything honorable to keep him here."[11]

By mid-July, 360 men were engaged with tremendous numbers of insects

in the biggest battles of the campaign to date. In the town of Dorchester an infestation of caterpillars occurred just fifty feet past the point where snow had stopped inspectors the previous year. In a single area of several acres, eighteen bushels of caterpillars were killed. William Tyner of Sargent Street in Dorchester found gypsy moth larvae clustered so densely on his oaks that they resembled a swarm of bees, and he said they could "strip a large oak tree down to twigs in three day's time."[12] In Boston, dense swarms climbed to the balconies of houses and in such great numbers they could not be knocked off as fast as they came. Mrs. J. T. Lane remarked that the caterpillars under her gutters lay "in one great, long, black, repulsive mass."[13]

The growth rate of the caterpillars was astonishing as well, and it became evident that they would pupate early. Although their doing so would limit the amount of foliage the insects might strip, it also ensured that a remarkable abundance of larvae would transform into moths and that the resulting number of clusters and eggs in each would exceed anything known before. Colossal colonies appeared again in Medford and Saugus, and the southern portion of the Middlesex Fells experienced its first severe defoliation. Workers found areas of dense infestation in the Fells where the caterpillars lay in blankets around trees, branches, and bushes and in thick, carpetlike mats on the ground. The committee was used to the defoliation of individual trees by the block in towns and villages, but this year the moths were in the forest, defoliating trees by the acre. The cyclone burners roared incessantly as workers formed skirmish lines to halt the swarming caterpillars. Ornamental vegetation was sprayed with lead arsenate, but the ratio of 10 pounds to 150 gallons had to be tripled.

As the caterpillars continued to invade the woodlands, the committee was forced to deal with acreage containing mature trees, which they did with the only tools they had—axes and fire. In Woburn, ten acres of mature oaks forty to sixty feet tall were cut, and the land was burned over twice.[14] Although cutting deprived the next hatch of food, the work only partially damaged many of the thickly dispersed egg masses. Tens of thousands of individual eggs were scattered on the ground, and the oil soakings and burnings that followed failed to destroy them all.

Work was most difficult on metropolitan parklands, as park commissioners ruled out the cut-and-burn method favored by the gypsy moth committee. Meetings were held to resolve the problems, and the committee always took great pains to report how harmonious they had been and how much mutual cooperation had been attained. But Leland Howard noted that the commissioners had been "far less complaisant" than individual landowners. And even had the commissioners turned matters over to the gypsy moth committee, it would have become apparent that Forbush did not have enough money or

men available to carry out the work; he would have had to abandon other areas to send men into the woodlands, and the net gain would have been zero. Still, the reluctance of the park commissioners to allow drastic measures in the Middlesex Fells and elsewhere was perhaps the final factor that made winning the gypsy moth war impossible. The committee could only hope that the park commissioners would recognize the consequences of their policies. All that could be done until then was to stabilize the situation, with the centers of moth infestation cordoned off and besieged by the state.

There was something about the view of the common man toward bug slaughter that brought out derisive streaks in Forbush and Fernald. With Forbush it is seen in his condescending condemnation of conditions found behind the dwelling places of common folks, and with Fernald it comes out in his presidential address to the Eighth Annual Meeting of the Association of Economic Entomologists in August 1896: "Last year the chairman of the board of selectmen in a Massachusetts town refused to use any of the public money for the protection of the trees along the streets from the cankerworms, because the idea of fighting insects was 'agin nature.' This year that same man's apple trees are as bare of leaves as though a fire had run through his orchard, and therefore I am of the opinion that it will be 'agin nature' for that man to gather a crop of fruit from his trees this fall."[15]

Fernald was so desperate to vanquish the moth that he championed imposing a "moth tax" on every citizen in the state, and he believed that if the insect escaped the Commonwealth, the tax should be levied on the entire country. He saw nothing wrong with the practice of trespassing on the land or premises of citizens to exterminate gypsy moths. His only reservation about accepting funds from the federal government was one of state's rights: he did not think agents of the federal government should be allowed to enter the lands of private citizens but thought the practice permissible when done by the state. If citizens were unhappy about the invasion of their property, campaign leaders were unsympathetic. Fernald regarded it as necessary to achieve the ends of the campaign and believed that the average Massachusetts citizen should accept trespass by state workers as "the lesser of two evils."[16]

Insect Predators Arise

In the thick of the most discouraging battles of the war came some good news: a rise in insect predators of the gypsy moth in almost all stages of its life. Wasps and hornets were observed chasing male moths and capturing them on the wing; *Vespa maculata* was very active in this respect. During the larval season, *Polistes pallipes*, the common paper wasp, was frequently observed stinging and killing gypsy moth caterpillars, eating part of them and then

flying off with other parts to provision the embryo cells in their nests. The wasps were active for hours every day, taking one gypsy caterpillar after another. Ants were active in attacking female moths at egg-laying, while harvest spiders (*Phalangium dorsatum*) consumed eggs from within the clusters. *Phidippus tripunctatus*, another spider, killed gypsy moth larvae in the field and in the insectary. Native Calosoma, Harpalus, and Carabas beetles fed continually on caterpillars, while some species of Dermestes attacked the pupa and devoured eggs in the clusters. Tiger beetles (Cicindela), assassin bugs (*Sinea diadema*), centipedes (*Lithobius forficatus*), and spiders—the cobweb weaver (*Steododa borealis*), the jumping spider (*Phidippus galathea*), and several others—were also destroying the insect.

Parasitic Diptera were seen laying their eggs on the caterpillars. Predaceous Diptera such as *Dasyllis sacrator* attacked female imagoes at egg-laying, while *Asilus sericeus* was observed to seize flying males. Insects of the Hemiptera and Heteroptera were among the most useful of all predators, especially *Podisus serieventris* and *Podisus cynicus*, the soldier bugs, which were widely distributed throughout the region infested by the gypsy moth. Mites were very effective in destroying egg masses and were considered important predators because of the speed with which they accomplished their aims.

News of rising predation was encouraging to Fernald as he continued correspondence with European colleagues about natural predators. Although the replies he received were helpful, the gypsy moth in the old country could be found over such an extended range that Europeans had never contemplated extermination, preferring to deal with it only at those times when localized population increases made it destructive. Population outbreaks and injury to forests and orchards were much less severe in Western Europe than what Fernald saw in North America, and Fernald's European colleagues were astonished by the reports he sent to them. Experts such as Antonio Montiero of Portugal, Professor Henry of France, Professor N. Nasonov of Russia, and Max Fingerling of Germany, to a man, believed that destruction of egg masses offered the best hope for control. Even the greatest European experts were convinced that importing insects would be a wasted effort. Bernard Altum, a well-respected German entomologist, dissuaded Fernald from making any efforts along those lines: "I have never known of a devastation in Germany equal in severity and extent to that in your country. So far as I know, all of the devastations of dispar in this region have occurred on limited areas, and have always quickly disappeared. An importation of predaceous insects to oppose this destructive dispar, e.g. Calosoma sycophanta, etc., cannot possibly be of any industrial importance."[17]

The failure of pesticides and the rise of natural predators compelled Fernald to continue investigating parasites, and he began to collect native "bugs," as

he called them, that preyed on the gypsy moth. Not trusting himself to identify them, he sent them to P. R. Uhler, a knowledgeable amateur entomologist in Baltimore, to be named.[18]

Small animals were the next group observed attacking the moth. Skunks devoured female moths on the ground and ate pupae as well. Wood frogs consumed female moths, and tree frogs would take small larvae. Common garden toads were almost machinelike in their consumption of gypsy moth larvae and were especially effective in brush land. One dissected toad was found to have eaten sixty-five larvae in a single day. Many of these effective control creatures, however, had been driven off, suppressed, or killed outright by being drenched with arsenical sprays or incinerated alive by the cyclone burners.

Canker worms were numerous during 1894 and 1895, and outbreaks of Tussock moths added to the general misery of the state. For the first time, trees were dying after successive defoliations. It was frustrating for the fieldworkers to fight an infestation of gypsy moth caterpillars defoliating a stand of trees while another kind of larva defoliating a different stand nearby had to be left untouched. Most of the birds that had considerably reduced gypsy moth populations in the past were glutting themselves on the hairless canker worms. Until this point, even Forbush had maintained that predation by birds was not a significant factor in depressing moth populations, but the difference this year was so striking that it could not be ignored.

During the early summer, experiments and research that had been done at Amherst and in the Malden storehouse were consolidated in a new insectary built on leased land at the edge of the Malden woods. This relieved the researchers of working in the swamplike atmosphere of the storehouse on Commercial Street and removed the risk that experiments would cause a secondary gypsy moth outbreak in Amherst, which was outside the boundary of 1891. The one-and-a-half story insectary building was rather small at sixteen by twenty feet but had a six- by eight-foot greenhouse on the south wall and a covered shed seven by eight feet on the north. Squeezed into the small space on the first floor was a main laboratory with closets, a private laboratory, and a chemical room. On the floor above was a single room for employees.

In view of Fernald's continual attempts to resign as entomological adviser, because of his workload, the committee elevated Archie Kirkland to the position of assistant entomologist, and he took over the entomologist's tasks at the insectary, where he had been working since 1892. The young man might have had his faults and temporarily succumbed to the temptations of youth, but Fernald knew him as a skilled and tireless worker and a promising young entomologist who had published twenty-six papers while he was still a college

Archie Howard Kirkland at the time he joined the fieldwork against the gypsy moth.

Photo courtesy of Special Collections and Archives, W.E.B. Du Bois Library, University of Massachusetts Amherst.

student. He was very fond of Kirkland and often referred to him as "my friend and co-worker."

The caterpillar advance during 1895 was furious but short. In the abnormally warm weather the larvae underwent fewer molts, and most of them pupated after six or seven weeks. This prevented the areas of defoliation from being worse than they would have been had the larvae fed longer. In some communities where ornamental shrubs and trees were being stripped, arsenate of lead at the rate of 30 pounds to 150 gallons of water was used to good effect. At the end of the season the workers were exhausted from their efforts, but Forbush reported that the outward thrust of the invaders had been blunted. Over a thousand colonies of the moth had been eradicated. The actions of the year ended in a draw, but in the now-silent woods, inspectors found uncountable numbers of egg clusters. Unless something new could be devised, the following summer would be a nightmare.

The insect kept appearing in localities both outside and inside the boundaries of the infested zone. In Saugus, Woburn, Lexington, Arlington, Medford, and the Middlesex Fells, at least three thousand acres of woodlands had become densely infested. Regardless of everything new the gypsy moth committee could muster, the moths always seemed to be one jump ahead of them. There was a serious new problem to deal with this year when Fernald discovered that the dreaded San Jose scale insect had finally reached Massachusetts and had been discovered in five localities within the western part of the state.

The early pupation of the gypsy moth did allow Forbush to begin a huge scouting project in June instead of September. He proposed to inspect all 12,000 acres of woodlands within the boundary of 1891, something that had never been done before. This project lasted through the year and was still unfinished when the appropriation ran out. Forbush planned to complete the work, weather permitting, as soon as the appropriation for 1896 was in hand.

The benefits were questionable, however: Bartholomew R. Hennelly was sent with a gang of forty men under Special Inspector Nelson and Superintendent Williams to scout portions of the Middlesex Fells near Grosvenor Avenue in Medford. Because Forbush would not allow men to work in areas where they lived, all the men in the party had come from other parts of the state and were not familiar with these woods. A line was formed with the men roughly one hundred feet apart, and the scouting began. After about a mile, the line became hopelessly separated, and Nelson and Williams decided to reverse direction. About ten men had wandered out of earshot, and the thirty men who could be located were sent off at a trot through the woods, attempting to check the trees for moths while keeping each other in sight. Hennelly said that three or four more of the remaining men got lost and straggled out of the forest some time later but that not a single tree in the Fells was scouted.[19]

Riley and Fernald at the Entomologists' Annual Meeting

The seventh annual meeting of the Association of Economic Entomologists was held at the end of August 1895. On the afternoon of August 28, Fernald presented a lengthy account of gypsy moth work in Massachusetts, using specimens and photographs to illustrate his talk. Some aspects of the lecture and the discussions with Riley that followed were remarkable for their candor—as Fernald surely recognized, for he told officers of the association that his comments were not for publication. When C. L. Marlatt asked permission to publish a redacted transcript, however, saying the talk was "the most satisfactory and interesting statement of the work of the commission that has ever been made," Fernald changed his mind.[20] Of his association with the work in Massachusetts since 1891, he related: "I was then asked to act as entomologist [to the committee], and in an unhappy moment, I consented, and, although I have since resigned, the committee has declined to accept my resignation, and I still hold that position. I was at first prone to judge of this foreign insect by the habits of our home insects, and I am not sure but that Professor Riley and I both had the same inclination."[21]

Fernald went on to say that Scudder's advice to destroy the egg masses had been right, and that in the five years he had spent studying the gypsy moth he

continued to find new and startling facts no one had anticipated. He admitted to a mistake in basing all his advice on his lab studies, since it had become obvious that the gypsy moth behaved differently in the field. He noted that the responsibilities of his position weighed heavily on him and accepted the blame for anything that had gone wrong, saying that he had given the best advice he knew how to give and that only time would tell whether or not he had been right. Fernald was not ashamed of what he was doing. His state was making a magnificent fight, in his opinion, not only for itself but also for the whole United States.

Riley, recently resigned as chief federal entomologist, was at last unburdened from the need to speak in guarded terms and defend his actions.[22] He apologized on the record for his harsh criticisms of the earlier gypsy moth commissions. It was, he said, due to his misunderstanding that the hardiness of this exceptional insect prevented control by ordinary means, and he now knew that the failure to eradicate the moth was not due to any ineptness on the part of those charged with its extermination. Riley also said that perhaps it would be better not to have the work done by a state commission but to let individual landowners take responsibility, which was the way problems with all other insect pests were handled. The events in Massachusetts had shown him the danger of applying conventional remedies to insects about which little was known. While he had always favored extermination by spraying and had thought that destroying egg masses would be a waste of time and money, Riley admitted to the assembled entomologists that his position on these subjects had been extreme.

Less than three weeks later, on September 14, 1895, Riley lay dying on a cobblestone street in Washington, D.C. While racing his high-wheel bicycle with his fourteen-year-old son, he hit a granite paving block that had fallen from a wagon. He was thrown over the handlebars, hit his head against the pavement, and fractured his skull. He died that evening, leaving behind a wife and six children. He was fifty-two years old. In a strange coincidence, just ten days later, on September 24, the great French scientist Louis Pasteur died in Paris. It had been Pasteur's discovery of the microscopic origin of silkworm disease that had saved the silk industry worldwide and was probably a major cause of entrepreneurs' abandoning their work with American silk moths. Death had removed another principal figure in the gypsy moth war that year with the passing of E. Leopold Trouvelot, age sixty-eight, on April 22 at Meudon, France. Even though Trouvelot's rash actions had caused great troubles and horrific expense to the people of Massachusetts, there is hardly to be found any record of harsh words spoken against him or condemnation of his acts.

Business as Usual

In the midst of trying to rid eastern Massachusetts of the gypsy moth, a number of different people came to the same conclusion: there was an opportunity to make money from this insect. The tactics adopted by the leaders of the war to achieve their ends opened wide the door to lucrative speculation and avaricious enterprise, a door through which some of the ingenious people of New England eagerly rushed. With a reluctant or wavering landowner of a large woodlot or woodland acreage, the committee would first attempt a conciliatory approach, explaining the ravages of the moth and offering to reduce the damage the landowner would suffer. The committee gained nothing by understating its case, and fear alone was often enough to persuade the landowner to permit heavy thinning, or sometimes a complete clear-cutting, followed by several burnings of the brush. The landowner was told that he came out ahead because the Board of Agriculture paid the cost of felling his trees. The argument would be made that cutting trees and burning brush improved the woodland and raised its value. But if the landowner remained obstinate, the committee would turn to a group of "complaisant" men who would offer to buy the infested acreage. No records naming these men survive, but they were likely shrewd individuals who used the weight of the committee and the inferior position of the landowner to further their own ends. Land changed hands at distressed prices, the buyers knowing that the committee would fell the timber and clear dense undergrowth. These new owners would sell the best logs for furniture and the remainder for firewood. They sold or rented the acreage for agricultural land if they did not plan to use it themselves, or they subdivided the property and sold it for building lots. The committee later claimed that moth colonies in these woodlands had been wiped out, when in fact it was the woodlands that had been eradicated.

Men who owned large tracts of timber became ardent supporters of gypsy moth work and appeared at hearings year after year to speak in favor of extermination. Some lobbied their state representatives, as Senator L. W. Ross testified at hearings held later in the decade: "One man, who is a very wealthy man and one of our best citizens, said that he had been informed that I was opposed to the gypsy moth appropriation, and he hoped I would see my way clear to change my views, and I asked him why, and he says, 'I will admit that it is a rather personal matter; I own considerable land over there and they have cleaned up my land for me. . . . [T]hey have asked me to come and see you, knowing I am a friend of yours, and see if I could not induce you to vote for this appropriation.' "[23]

Senator James E. Bailey of Arlington contended that among the few people in his district who favored gypsy moth work, most were individuals who had

benefited from the labors of gypsy moth gangs. Certain legislators from Boston known as "machine Democrats" viewed the entire gypsy moth campaign as a kind of make-work program that provided jobs for unemployed men in their districts. Many of these politicians did not believe that the gypsy moth could be exterminated, and Bailey said some of them had told him so personally, but they continued to vote for the appropriation.[24] Bailey told the story of one gypsy moth man who was working on land adjoining his father's property in Arlington: "He had been up a cherry tree and was on the ground, using opera glasses, etc., looking for nests and moths. He was doing his duty; I don't deny that. A little girl of about eight years old stood about and watched him looking for these moths, etc. She said to him, 'What are you looking for?' He said, 'Two dollars a day.' "[25]

Since the first spraying devices at the committee's disposal were crude and unreliable, warranting development of improved apparatus, equipment manufacturers also found opportunities for profit. Some worked to make wagons that could bear the weight of large barrels of pesticides even on rough terrain. Others began to develop lighter and more powerful backpack sprayers, nozzles, and tanks that would allow spraying to greater heights. Nozzles, hoses, pumps, tanks, and couplings all needed to be reinvented. Forbush placed his brother-in-law, E. C. Ware, in charge of employees at the Malden machine shop, and a two-year program to develop, build, and test new spraying equipment began.

Chemical companies and private entrepreneurs submitted dozens of samples of new pesticides that they claimed would kill gypsy moths. These mostly worthless concoctions were given to Fernald and his small staff for testing, straining the resources of the scientific corps, which exhaustively appraised every sample. A. B. Ward noted that Fernald not only tested insecticides from outside sources but also worked on the development of new formulas himself.[26]

The Battle Rages On

The Commonwealth's problems in its attempts to eradicate the gypsy moth, according to an amazing assertion from a European entomological society, occurred because American entomologists did not realize that the female gypsy moth could fly as powerfully as the male; if the Americans would make late night observations, they would confirm this for themselves. This claim baffled and disturbed Fernald just as he was bringing the gypsy moth monograph to completion. Forbush assigned men to work in the forests all night long looking for flying female gypsy moths. Failing that, he built several of what Fernald later described as wooden "Towers of Babel" around some

trees, and field personnel ascended into the leafy canopy to make nocturnal observations of specially painted lady gypsy moths.[27] All this effort went for naught, and afterward Fernald was irritated about being criticized for not reporting what he didn't find.

So much money had been expended in the struggles of the year that Forbush had to release 116 men in September. The remaining 152 men, his most experienced veterans, continued their inspections. Forbush sent them again to the peripheral towns, up and down railroad lines and well-traveled roadways, and sometimes into adjoining states. Before they were through, the men had inspected well over fourteen million trees and found only about 6 percent infested with the gypsy moth—though scouting revealed such astonishing numbers of egg masses in the recently infested woods that the hatch of 1896 promised to be the worst of the entire campaign.

Although Forbush admitted that the contest against the moth had appeared hopeless, by the end of the year he believed the insect had been held in check and that conditions in the infested woodlands were not as severe as he had feared. Three forested regions of about a thousand acres each—the portion of the Middlesex Fells that lay mostly in Medford, the northern Lynn Woods near Saugus, and woods that lay partly within the common borders of Arlington, Lexington, and Malden—would take years to clear, but the situation elsewhere, he claimed, was better than it ever had been before.

The year had been a difficult one for Fernald. He again invited entomologists from nearby states to tour the infested region and make recommendations. The visitors were pleased with what they saw, he said, but he did not publish their comments: "These reports have been simply for the legislature, and how many members of the legislature will read a report of any length when you are asking for money? The more money you ask for, the less they will read your report, and the committee has said these reports must be very short."[28] He was still dissatisfied with his situation at Amherst; he was behind on almost all his work there and could not seem to find a way out of his responsibilities to the gypsy moth committee. Despite his reluctance about being dragged ever deeper into the embrace of economic entomology, he still yearned for success and respect as a systematist, and he stubbornly pursued work on his monograph on the North American Pyralidae. For reasons known only to him, he also undertook the "Herculean task" of working alone on the entire group of Microlepidoptera in North America. He wrote to Scudder of the "intense pressure brought to bear on me from all over the country to work up and describe new species" and of the lack of leisure time that drove him to work as he did "whether I will or no."[29]

Fernald spent a good part of the year writing his half of the gypsy moth monograph, but his heart was not in it. He put off the obligation as long as he

could and tried to persuade Henshaw to write most of it for him.[30] He quarreled with Forbush over which of their names should appear first. In addition, he was so upset with the colored plates drawn by Joseph Bridgham of Providence that he refused to accept them until overruled by the committee, which was determined to have the book ready for the state printer by the first of the year.

[CHAPTER 12]

The Politics of War (1896)

While conditions in the field were becoming more fluid, conditions in the legislature were hardening over the question of funding. Rumors flew that opponents of extermination had enough votes either to reduce the moth appropriation to a crippling level or to defeat the bill altogether. The constantly changing nature of events had brought the war in from the fields and forests of eastern Massachusetts to the streets of the capital city, and the next great battle would be waged in the corridors of the State House in Boston.

The committee had carried over nearly $40,000 to pay the wages of 121 men through mid-March 1896. This force spent most of its time creosoting egg clusters, burning brush, and felling trees in preparation for the summer. All involved hoped their appropriation would be approved early, but Forbush heard persistent rumblings from the legislature that obtaining any funds would be no easy task. To ensure the swiftest possible response, Sessions placed the committee's annual report in the hands of the senate clerk on the first day the legislature was in session—ten days ahead of the date required by law.[1]

The committee and its top people by now were spending as much time in back-room maneuvering as they were fighting moths in the field. Hearings were scheduled before the agriculture committee on Tuesday morning, January 28, in the State House. Fernald, Forbush, and Sessions believed they were vulnerable, and there is a surge of correspondence between them concerning tactics, strategy, and the influence of their friends and foes in the legislature. Many letters are couched in guarded terms, and the preparations for the critical hearings are often referred to as "the other matter," or "the matter now before us." On January 22, Sessions wrote asking Fernald to come to Boston the day before the hearings and discuss strategy: "We think we have a good legislative committee and we want to put in our case with shrewdness so as to cover the ground and not tire the [committee]. We want your advice and we also want advance notice what the others will say and arrange to avoid repetition and increase the proper presentation of all points necessary."[2]

The hearings began on January 28, and the transcript reveals that the board's strategy was to deflect all criticisms and smother the opposition with economic entomologists. Without saying whether it was likely, Sessions, Forbush, and Fernald would argue that exterminating the moth was possible, but with the proviso that enough money always be available. Every opportunity would be taken to recount the insect's ravages in Europe and to maximize the tales of caterpillar swarms in the Commonwealth. Fear of the gypsy moth was to be their cudgel, and it was a weapon they wielded with a practiced hand.

Sessions was a savvy political infighter by nature and experience, and he had devised a strategy to take advantage of inexperienced adversaries. He opened with an audacious gambit by reading into testimony portions of a speech that Leland Howard had made in 1894, material so prejudicial to his cause that one might expect his opposition to use it. Sessions intended to show that although the nation's highest economic entomologists appeared not to believe the gypsy moth could be exterminated, those appearances were deceiving. Howard's excerpt stated, in part: "Under the circumstances, therefore, any course other than energetic and well directed effort to keep the insect within its present boundaries will be shortsighted in the extreme, although it is doubtful to my mind whether absolute extermination will or ever can be brought about."[3]

To counter such statements, Sessions dribbled hearsay evidence into the hearings often, including his secondhand opinion that Howard had not meant everything he wrote. He said Howard had admitted privately that his doubts were based on his perception that the state would discontinue appropriations.[4] Sessions made another utterly surprising point by claiming that Howard was prevented by his superiors at the USDA from expressing favorable opinions of moth work. He suggested that these restrictions had caused Howard's personal statements to be taken out of context, that most laymen could not understand what Howard had meant, and that it had become a sore point with Howard to be constantly misquoted.

Fernald confirmed that only he and a small group of his peers could understand insect work. He was proud that the United States was ahead of Europe in economic entomology because the Europeans did not use insecticides: "I was in Berlin in 1889 and the trees all around were filled with [female] gypsy moths. . . . I asked an official of the public garden if they had ever used poisonous insecticides and he had never heard of such a thing. He said they would begin the next day with fire engines and wash the female moths down to the ground and crush them [with rollers]. Just think of that."[5]

Fernald told some horror stories about gypsy moth swarms in Europe. One favorite was about the time police in Penza, Russia, were mobilized to shovel

up mounds of dead caterpillars because the horrible stench of the decaying insects made people sick. His question about who would want to live in such conditions, however, was parried by Warren Frost, one of four brothers, market gardeners, who was unimpressed by such shopworn tales of terror. Frost said any market gardener in Boston would be happy to have so much wonderfully rich decaying matter for fertilizer and called Fernald's bluff by asking to be told where such heaps could be found because he wanted to buy some.[6]

On the second day of testimony, Forbush took the stand to defend his actions. He admitted that the work had gone slowly because of the high standards he set for the workers, but he felt that if a tree died as the result of defoliation or careless work, he personally should be made to pay for it. He explained his strategy of making successive passes to diminish the enemy's numbers and said that his ultimate goal was "to sweep these insects into the sea."[7] Barker asked what he would do if given a million dollars; an amused Forbush responded that he could never find enough men to justify such a big payroll.

Forbush revealed that he and Fernald "had almost come to blows" on the subject of parasites.[8] Forbush and many entomologists believed the state should import parasites, but over the years they had come to agree with Fernald. Fernald affirmed that he refused a request from the gypsy moth committee to go abroad for this purpose, saying he feared that introducing secondary parasites might make matters worse. Using a seafaring term, he told Barker, "There are a great many holes in this skimmer . . . and I do not feel like soldering them all up."[9]

Whenever the brothers Varnum and Warren Frost were in the room, they hurled stinging criticisms at Forbush without mercy. Varnum thought the anxieties about insect dangers were unnecessarily raised, and he questioned the dioramas and other displays that the gypsy moth committee had sent around the region:

> What are all these preserved pictures [and displays] brought here for? It is to strike terror into the souls of the [hearing] committee. What did we have the exhibit at the Mechanic's Fair for? All the birds stuffed on an old dead tree and two old hens at the base of it picking up gypsy moths. . . . It is so that thousands and thousands of people might see that dreaded pest. . . . As far as the Board of Agriculture is concerned, in making their selection for a field director to engineer this big scare, they could not have gotten a better one if they had raked the Commonwealth all over.[10]

After listening to Forbush explain scouting and how his men painted marks on the trees to indicate their condition, the work done, the crew responsible, and the date of completion, Varnum Frost complained that there was a tree in the yard next to his that had "half the alphabet on it."[11] Frost noted it was no secret in Arlington that the properties of certain parties were well cared for, citing one instance in which an estate of thirty acres had received days' worth of treatment, whereas not an hour of work had been done in the adjoining yard. He also disliked what he called "the big scare." He said growers were told that half a billion dollars' worth of crop damage was done annually by insects, yet the market was so glutted that Massachusetts growers had a difficult time selling their produce.[12]

Warren Frost was incensed that gypsy moth gangs were pouring acids into tree hollows and burning out cavities with fire to kill egg clusters or larvae. He said such work drove away insectivorous bluebirds and owls and destroyed their nesting places, which he called "the most terrible practice I ever heard of."[13] Further, he was losing his patience with the exaggerated claims of the board: "I have been acquainted with this board for several years, and the wise ones have all drawn out of it, and I recommend to Brother Sessions and Mr. Forbush not to hang on too long. It's going to burst; the whole thing is going to burst. The sentiment is setting in strong. We are not going to be hoodwinked much longer."[14] The four Frost brothers refused to permit gypsy moth gangs on their farm and removed burlaps that Forbush's men had tied on their trees, saying they would take care of their land themselves. At one point Forbush visited the Frosts personally to order the burlaps replaced under penalty of law, and a tense standoff of several months ensued before Forbush decided to let the brothers have their way.

The records of the 1896 hearings are incomplete between January 31 and February 23, but some information about them is found in letters written to Fernald by Kirkland, Howard, and Forbush. Fernald had fallen ill after the hearings of January 31 and returned to Amherst, leaving an excited Kirkland alone to experience the unfolding drama that would likely decide the fate of the gypsy moth committee. Kirkland attended most of the hearings and wrote often to keep Fernald apprised. By February 1, he thought the matter was well in hand, noting the appearance of only a few opponents, whom he characterized as "feeble" and "mostly dead and wounded."[15] But Fernald reminded him not to count his chickens before they hatched, and Kirkland was forced to agree by February 6, when he learned that the greatest opposition would occur after the hearings, when the appropriations bill went to the floor of the house: "Guess your advice about not counting legislative 'chickens' is good. F. H. Appleton we are told is aiding and abetting a petition to the House

asking that the amount of appropriation be made $50,000. This possibly to please Bailey [the] ex-representative from Arlington and Winchester . . . I'll stop here; think probably you'll need to go out and chase yourself around the house to rest your head after reading this."[16]

Appleton was not some ignorant citizen to be brushed off. He had served on the gypsy moth committee for three years and was a respected member of the Board of Agriculture. In the months since he had traveled to Washington as a member of the Massachusetts gypsy moth delegation, he had concluded that too much money was being spent trying to accomplish the impossible, and his views carried a great deal of weight. Appleton had invited Leland Howard to speak before the Massachusetts Horticultural Society on February 15 while the hearings were still going on, and Howard had accepted. Forbush was convinced that Appleton would use the occasion to let an unwitting Howard make statements that could later be used against the gypsy moth committee. To prepare for what lay ahead, Forbush urged Fernald to meet Howard's train at Springfield and ride with him to Boston.[17]

Fernald wrote to Howard in Washington; Howard told Fernald on February 10 in a letter marked "private" that his talk would be on scale insects, not gypsy moths:

> I feel, however, that I must be posted as to [Appleton's] exact attitude and as to whether he is in any way antagonistic to yourself and the present Gypsy Moth Commission before I express any sentiments on the subject of the Gypsy Moth to him in conversation. I am therefore hurriedly writing to you to see if you will not immediately let me know any facts which I ought to know. . . . [W]rite me immediately on receipt of this letter addressing me at the University Club Boston where I shall arrive on Friday night.[18]

Howard's letter of the tenth and Fernald's of the eighth crossed in the mail, but Howard wrote again on the eleventh asking Fernald to explain briefly his support of extermination so that he (Howard) would be in agreement with the gypsy moth committee should anyone ask. He said he wanted to see the experiment succeed and promised not to interfere—even though he had already concluded that extermination was beyond reach: "To you personally I do not mind expressing my doubts as to ultimate extermination, without an expenditure of a sum of money which will be entirely out of the question. But it is yet an unsettled point with me whether I have any right to advance such an opinion. The conduct of the investigation . . . will be such a magnificent experiment that I am anxious to see it carried out."[19]

Opponents regrouped behind the Massachusetts Society for the Promotion

of Agriculture and presented their case on February 23 through attorney Richard M. Saltonstall. Forbush became nervous again and asked Kirkland to write Fernald and implore him to return to Boston. Kirkland wrote the letter but decided he had heard enough and instead would spend those days with Fernald in Amherst naming insects.[20] The opposition presented their petition without animosity toward the board or the gypsy moth committee. As Saltonstall stated in his opening remarks, those opposed to the extermination effort simply wished to express their view that eradicating the gypsy moth was impossible and that the nature of the work should be changed: the committee should prevent the insect from spreading and restrict exterminative work to places where outbreaks occurred. The petitioners also recommended an appropriation of $5,000 to send Fernald abroad to arrange for shipping back parasites. Twenty prominent people—including Charles Sargent, head of the Arnold Arboretum; Francis H. Appleton, now a former member of the Board of Agriculture; Augustus Hemenway, a metropolitan park commissioner; and J. D. W. French, president of the Bay State Agricultural Society—had signed Saltonstall's petition. Seven other signers of the petition were trustees of the Society for the Promotion of Agriculture.

Saltonstall questioned Forbush about the number of men needed to inspect a million burlaps daily, hoping to show that the effort was impractical. He himself had computed that one man could examine three hundred trees in a ten-hour day, so the task would require well over 3,000 employees, which he called "a small army."[21] Forbush shot back that any man who could not attend five hundred burlaps a day would not be working long for him. Saltonstall recalculated his numbers and said the work would require 2,000 men, which he still thought was a small army.

Sessions hammered away on everybody, including his former colleague Francis Appleton, who had maintained for two years that extermination was impossible and that scientists and entomologists were divided on the point. Sessions tried to portray Appleton as one who would not listen to the advice of experts:

> Sessions: Did I understand you that your opinion of the possibility of this thing would not be changed by the opinions of economic entomologists on this matter?
>
> Appleton: I do not think I made that statement. I would not put my opinion against theirs. What I say is that where doctors disagree, I have the right to choose my own doctor.[22]

The protracted hearing of February 25 included the testimony of Samuel Scudder, Alpheus Packard, and Nathaniel Shaler. Scudder was the strongest

witness; there was no doubt in his mind that extermination was impossible regardless of the appropriation: "I was one of those consulted when the committee held a conference in 1891. I stated then that I did not believe in extermination, and I have found nothing since then to change my views. . . . I think the committee would have to expend $100,000 [per year] for a hundred years before they would get anywhere near extermination, and the last would be the worst of all."[23] Packard was a weaker witness but not on the point of extermination. He said it would be best to use fungal diseases to which caterpillars were very susceptible. Kirkland thought both men had sounded ambivalent and could not believe that any entomologist would speak out against the work of his brothers. He wrote to Fernald that Packard and Scudder must have been paid for their testimony and were under pressure to "do justice to those that had hired them."[24] Kirkland noted that Sessions's grilling of Appleton had been "very direct and somewhat severe and left Mr. Appleton in a rather peculiar light."[25]

The dread of the gypsy moth affected many at all levels from professor to private citizen, and fears were expressed in many ways. J. O. Goodwin of Medford, long an advocate of extermination, had become completely paranoid about the matter: "If we cannot exterminate this pest, let the pest override us and we will die . . . It simply comes right down to the survival of the fittest. If that infernal gypsy moth is able to conquer us, then we ought to die."[26]

Nathaniel Shaler testified that even though small and tardy appropriations had lessened the chances of success, the question of extermination was still open, and the state should make certain the insect could *not* be crushed before giving up. He repeated his argument that the gypsy moth could cause the fall of civilization: "Mr. Chairman, it seems to me that I do not exaggerate the importance of this question when I say that upon the extermination of this insect may depend the value of our agriculture in this Commonwealth and perhaps in every Commonwealth. . . . In other words, we are in the face of the greatest danger that this Commonwealth has ever put itself against. I know of no position which has been so serious."[27] When Saltonstall asked Shaler if he knew that Riley had expressed doubts about extermination, Shaler snapped back that he had "no confidence whatever in Mr. Riley's judgment."[28]

Shaler believed that the gypsy moth had been in the country since 1862, brought over in egg form "thousands of times" on the oaken shipping casks of imported wine. Shaler appears to have based his apprehensions on the few areas of defoliation he saw in Europe rather than the many areas where there was no damage. He was no doubt intent on doing as much as possible to get the appropriation, which may have influenced his testimony, or it might have been that he could not take a level view of the problem. He was an influential

man to whom other influential men listened with respect. His views were given the same weight as those of experts, and witnesses who opposed him were chided for their impudence, as Senator James A. Bailey of Arlington discovered:

> [Prof. Shaler] said that our civilization was threatened and might fall if the gypsy moth were not fought along the lines that it has been fought. . . . I was roasted on the floor of the house . . . because Prof. Shaler said that extermination was possible and I, a humble pupil of his, dared to think it was not possible . . . with all respect to Prof. Shaler, whom I love and who is one of the leading professors at Harvard University. . . . Prof. Nathaniel Southgate Shaler is not the professor of entomology there, he is professor of geology and paleontology. . . . [H]is knowledge of entomology I suppose he himself would say was not expert or profound.[29]

Forbush wrote to Fernald on February 26 to inform him the hearings had gone well, and that the opposition had not quoted Howard.[30] The agriculture committee visited the Middlesex Fells with Sessions and gypsy moth committee members Wood, Pratt, and Avery on February 27, and Sessions said the group "saw eggs enough to satisfy them on that point."[31]

Fernald's presence was no longer needed, and he could not have come anyway, because he was bedridden with chills and a fever. With Fernald indisposed, it became Kirkland's lot to rebut Packard and Scudder. Fernald advised Kirkland against tackling either one head on. The mild-mannered Packard was a man of considerable courage. During the Civil War he had received commendations for his bravery under fire and as a youth had undergone unsuccessful surgery to correct a cleft palate without anesthetics or antibiotics. Fernald impressed on young Kirkland the idea that he should speak of both men only in the highest terms and then use their testimony to make it appear that they favored extermination. Kirkland responded that he had "paid tribute to Packard and Scudder" and, as far he knew, had not said anything to embarrass Fernald or the gypsy moth committee.[32]

Sessions saw the opposition petitioners as weak, and his pugnacious style contrasted with Saltonstall's more avuncular and lawyerly approach. Sessions hammered the point that all the opposing experts were unqualified because they were not economic entomologists. He shrewdly worked from published documents and correspondence of economic entomologists without having any testify other than Fernald. The opposition could not compel independent entomologists to be present, so no examination of them was possible. The testimony from those connected with the extermination campaign in response

to direct questioning was remarkable for its nonresponsiveness. The witnesses were so evasive that at one point a frustrated Saltonstall could hardly speak straight.

Testimony heard in response to documents presented by Saltonstall showed that some economic entomologists did in fact think extermination impossible. Sessions and Forbush made the outrageous claim that every one of the entomologists who had voiced doubt about extermination—including Leland Howard, Joseph A. Lintner, J. Henry Comstock, and Charles V. Riley—believed the opposite and had said so in private conversation. The investigative committee was informed that the entomologists' doubts arose only because they thought Massachusetts would not appropriate enough money to do the job. Sessions finished up with some surprises for his frustrated opponents. The night before the hearings concluded, he visited a number of prominent Bostonians and obtained their signatures on a petition supporting extermination. He presented the petition to Chairman Barker the next day, saying that it took little effort to get signatures on a petition, and that the names on his petition carried no less weight than did those on his opponents' petition.

Next, Edward Forbush delivered his rebuttal. Forbush, a natural speaker, always sensed when his words would have their greatest impact. Given his brief but impassioned plea to continue the work, it is not difficult to understand why he always made a strong impression on those who met him:

> I have hunted this moth as a hunter hunts a deer. I have learned its habits and where to find it. I know when it is in a place and when it is gone. I tell you, gentleman, this thing can be done and if you give us the means we will do it. Let these people come in and say it cannot be exterminated. I am glad to have them express their opinion, but if we get the means to exterminate it, in spite of all carping we will go on and exterminate it. We will do it. We can do it. I know it.[33]

In closing, Sessions fired a salvo from Leland Howard in Washington. Since the opposition had presented documents in which Howard expressed doubt about wiping out the gypsy moth, Forbush had written to Howard imploring him to take a stand in favor of the Massachusetts campaign. Howard delivered a resounding vote of approval for his colleagues in Massachusetts without ever stating that extermination was either possible or likely: "I consider Mr. Sessions as a man of excellent common sense and wide agricultural knowledge; I consider you an executive officer beyond compare; I consider Prof. Fernald a man whose ripe entomological judgment cannot be questioned. You have all three given this gypsy moth such study as to make your opinions

worth a hundredfold more than those of any other individual or individuals. I am perfectly happy to abide by your judgment."[34]

The acrimonious tone, nasty tricks, and corybantic maneuverings behind the scene were not unusual for gypsy moth hearings. This one may have been the most contentious, because much was at stake, but there are references in other documents to the acerbic and spiteful relationship that existed between the legislature and the Board of Agriculture. In this case, though, opponents of extermination were not expecting such slashing attacks and had come to the hearings with confidence in Sessions, Fernald, and Forbush; they merely wished to have the moth program proceed along more realistic lines. Sessions took advantage of their conciliatory stance to make his attack most effective, but in doing so he created powerful enemies. There would be more hearings to come. Members of the opposition would not forget how they had been met, and the Board of Agriculture and its gypsy moth committee had not heard the last of Saltonstall and the men he represented.

Packing the Hall

The legislative hearings closed on February 28, but other public meetings occurred afterward. The joint agricultural committee held a hearing in Winchester on the evening of March 6 to take testimony from inhabitants of the infested district. Kirkland wrote to Fernald that the gypsy moth committee had been quick to ensure that friends of the work would be in evidence.[35] Oliver McCarthy, then employed by the gypsy moth committee, said that all the men on his gang were instructed to go to Winchester and pack the hall[36]—a recollection that was confirmed by Bartholomew Hennelly, another employee who showed up that night. A Winchester man said that he looked around the crowded room and had not been able to recognize more than six local residents, and Hennelly commented that outsiders did the greatest amount of talking: "An outside man that spoke there in favor of the bill was Mayor Allen of Woburn, who was invited there by one of the inspectors and made a very powerful plea for continuation of the work. . . . After the hearing was over he came outside and was talking to some of the employees about the hearing, and he told them he was thankful that the committee had not asked him to describe the gypsy moth, because he could not have told it from an elephant."[37]

Forbush and Kirkland had ensured that the Board of Agriculture was well supported, and in addition to invited officials such as Mayor Allen they got a surprising boost from a discharged inspector named Noyes, who claimed that he "came there not because he loved the management of the work but because

he was an honest man." Noyes's convincing speech and Allen's plea were enough to make several legislators reconsider their stance.[38] Kirkland and Forbush were elated by the results. Kirkland told Fernald, "We swept the boards—Nary a peep of opposition."[39] And Forbush exulted, "We have met the enemy and they are ours."[40] By March 9 the battle had swung in favor of moth extermination, but the Winchester gathering represented the last straw for Senator Barker, who had been at first merely dismayed by the political maneuverings of the Board of Agriculture but became deeply disturbed when he discovered that the board had packed the Winchester hall. Barker remained a force to be reckoned with, and the hopes for a quick appropriation were soon dispelled. Kirkland wrote that the "appropriation business is still hanging fire, owing to a split in the committee."[41]

Forbush depleted his budget and began laying off his remaining men. There was not much time left for cyclone burning before the insects emerged and crawled into the trees; the caterpillars had enjoyed two seasons of favorable conditions, and Forbush admitted to "many forebodings" about what the next season would bring. The legislative debate was still raging on April 23, but Appleton's plan for a reduced appropriation of $50,000 had been decisively rejected.[42] The contentious legislative debate seemed to have no end, but friends of agriculture in the General Court did push through a $10,000 emergency appropriation that became available on April 28. Meanwhile, the gypsy moths hatched, and as Forbush had feared, there were so many that his depleted forces could not contain them: "In some of the colonies where the burning was not done the scattered eggs on the ground among the dead leaves produced a sufficient number of caterpillars to strip the foliage entirely from the trees in the center of each colony, so that all the labor of the season of 1895 served only to prevent the increase of the colonies, and failed to contribute to the progress of extermination."[43]

Even when there was money, Forbush was having trouble finding enough men to push the work. The gypsy moth payroll contained over three hundred names, but the number working on any given day averaged fewer than two hundred except for a few months in the summer. To relieve Forbush of his burden and allow him to direct operations from his command center, the gypsy moth committee voted repeatedly to enlarge his office staff and administration. Both Forbush and Fernald had assistants, and superintendents were given deputies. The structure had grown to include agents, general agents, special agents, special inspectors, and acting inspectors. The staff of the office and storehouse fluctuated, but usually included a bookkeeper, stenographer, two clerks, three copyists, quartermaster, storekeeper, teamster, purchasing agent, mechanic, machinist, draftsman, and a custodian. The result, in the parlance of the time, was "a head too big for the body."[44]

Fernald was again wearying of all the contentious aspects of working for the gypsy moth committee. Even the release of the monograph in May did not cheer him. *The Gypsy Moth*, at its final length of almost six hundred pages, was received with great praise in the world of economic entomology and indifference almost everywhere else. That American entomology, in the space of six years, had come to know more about the European gypsy moth than the Europeans did was generally unappreciated by the public at large. Fernald felt only relief that the monograph was now out of the way; it had cost him "a vast amount of time," and "as a work on economic entomology it is as well done as I can do with the time at my disposal."[45] He was eager to hear the opinions of his colleagues, especially those outside the field of economic entomology such as Scudder, and he became "exceedingly annoyed at the negligence of the parties at headquarters in sending out the gypsy moth Reports." He wrote to Scudder, "If we live long enough you will doubtless get a copy," and complained he did not know how to make Forbush's staff work faster.[46]

On May 29 he wrote once more to resign his post as entomological adviser. Sessions replied a few days later: "Yours of May 29 containing resignation as entomologist to the gypsy moth committee . . . received. . . . I know that the committee and Mr. Forbush will be very reluctant to have the official connection between yourself and the committee severed. It will seem like the beginning of the end and the committee will feel weakened and bereft without you. . . . The committee have looked to you as a tower of strength in this work."[47]

The appropriation finally went through the house on May 14 after a bellicose debate. The bill worked its way through the General Court, and the governor signed the resolve on May 21—after Senator Barker managed to reduce the amount to $100,000. Several years later Barker said that his actions had saved the state $50,000 dollars and that of all the deeds he accomplished in the legislature, this one pleased him the most.[48] The appropriation, less the $10,000 emergency fund, became available on June 4, and the long and damaging confrontation temporarily came to an end.

Forbush had used a skeleton force to continue the fieldwork and even now had to carry on with only half of what he needed. He began to band the trees before the larvae pupated, but there was not enough time to complete this task. Colonies had become so large that many more trees needed burlap, but the men had to stop banding new trees in order to check the bands already in place. By June 20 the force abandoned the central districts and spent the rest of the season killing caterpillars in the outer towns. The caterpillars swarmed out of the infested parklands in the central district and once again took possession of the inner towns.

Two new but well-established colonies were discovered in Brookline, and

Forbush diverted what few men he could to reduce the worst of that infestation. Trees in the woodlands had suffered two defoliations in one year, and in several places a number of them were dying. Lead arsenate at the rate of 20 pounds to 150 gallons of water was used in portions of the Middlesex Fells; Forbush believed the kill ratio this year was close to 99 percent. The moths were pupating by June 23, which Kirkland said was the earliest date on record. The colonies in the Lynn woods, Saugus, Medford, and Woburn were very bad. In one hundred-acre area of Lynn, 400,000 egg clusters were removed but at least as many left untouched.[49] Kirkland jotted a quick note to Fernald that "the wooded region round about is pretty thoroughly infested."[50]

With Forbush's needs attended to, the state appropriation in hand, and the fieldwork passing for normal, the gypsy moth committee was able to devote its attention to Fernald's resignation. Fernald claimed that he had scarcely worked a full day on his own research since the gypsy moth committee was formed, and he did not want to delay his projects longer. He had either tendered his resignation or asked to be relieved of his duties every year since his connection with the committee began.[51] These repeated attempts had always hit hard, and the climate surrounding the work was now so unfavorable and the eradication program enjoyed so little support that only Fernald's presence imparted any credible standing with the state's citizens and the scientific community. Consequently, Wood responded to Fernald:

> The committee feel that your withdrawal from connection with the work will largely take away its prestige with scientists throughout the country, and imperil the success of any effort that may be made to induce the federal government to assume the work or assist in its prosecution. . . . The committee will also be shorn of strength which your experienced advice has always given them, and fears that your resignation will be interpreted by the public as an acknowledgement of the hopelessness of a continued contest with the moth.[52]

In August, Massachusetts endured a horrific heat wave of such tenacity that men and women were dying on the street, and the prolonged high temperatures taxed the men at work in the field who were compelled to wear a uniform jacket. Yet Forbush maintained a torrid pace and burned through almost his entire year's appropriation in just ten weeks. Funds ran out in mid-August, and large numbers of employees were furloughed. Kirkland wrote to Fernald that he and Burgess were the only men left in the scientific corps.[53]

The committee continued to insist that the gypsy moth was a danger to agriculture, even though it was ever more manifesting itself as a forest insect. Many economic entomologists perpetuated alarmist arguments, including

John Bernhard Smith of Rutgers, who at this time was president of the Association of Economic Entomologists. Smith called the gypsy moth "the most dangerous pest ever introduced into the United States."[44] His gloomy argument did double damage, since it appeared in his textbook of economic entomology from which future generations would study.

Conditions in the wooded heartlands became worse during 1896, and the forces of the state were stretched too thin to contain the insects. When the towns were cleared, moths from the woods reinfested them; when the woods were cleared, moths from the towns reinfested them. It only took a year or two for the insect to recover from the most punishing losses. Areas frequented by tourists were almost impossible to keep cleared. Insects were found every year in the wooded groves surrounding the graves of the poets Lowell and Longfellow in the Mount Auburn cemetery, and insects constantly reinfested the Bunker Hill monument and the site of the Charlestown carnival. Drill fields, camping grounds, and the land around churches, schools, hotels, and public offices also presented an endless problem. Similar situations began to occur elsewhere in the state, and the committee told the legislature they wanted to make a complete inspection of the entire Commonwealth.

The committee compiled records of commercial trade through Medford and Malden: the kinds of cargo, the frequency of trips, the nature of the business, the destination of the wagons, whether the return trip was made full or empty, and even the places where the drivers stopped to rest (it learned that a surprising amount of manure and swill was in motion on any given day). The heaviest wagon traffic went south into Boston, but the committee was persuaded that the city's lack of trees made it inhospitable for the gypsy moth. Further, the members believed that the areas south of Boston would remain free of the moth and did not pay much attention to them—with the result that commercial vehicles moving out of Boston toward the south were not checked and carried the moth into regions that were thought to be safe.

In the fall the few remaining men creosoted egg clusters, and at year's end they were working their way back toward the central district. Although Forbush believed that the outer woodlands were in good condition, the metropolitan parks concerned him, and he must have wondered at times whose side the park commissioners were on. Once streets, driveways, boulevards, and electric railcar lines had been cut through the woods, creating a network of transportation and recreational driving, Forbush estimated that over a million egg clusters had been laid in the Fells alone—representing a potential hatch of 500 million caterpillars. If the roads were not closed during the caterpillar season the larvae would be dispersed far and wide.

By the end of the year's work, Forbush's records showed that of more than ten million trees inspected, only 5 percent harbored egg masses. Over half a

million trees had received burlaps, and about 132,000 had been cut down. Inspectors had examined 25,000 buildings, 44,000 wooden fences, and some 300,000 linear feet of stone walls. The larvae destroyed by hand numbered nearly two million, and almost 442,000 pupae and over 44,000 imagoes had been destroyed. Forty-three hundred trees had been sprayed with lead arsenate, and 885,000 viable egg masses had been creosoted.[55]

Thousands of old orchard trees were cut down and burned; while others that were old or damaged but still considered productive had cavities filled with cement or sealed up with sheets of tinplate—which deprived the gypsy moth of places to deposit eggs but also eliminated the favored nesting places of bluebirds. The remaining nesting places were possessed and defended first by English sparrows and then by starlings, which drove the remaining bluebirds away. This beautiful songbird was turned into a rare species in eastern New England; the best that could be expected was that once the war against the gypsy moth—grimly lead by the ornithologist Forbush—had ended, the bluebirds would somehow reestablish themselves.

The Association of Economic Entomologists passed another resolve at its August meeting in Buffalo that failure to continue the work in Massachusetts would be "a national misfortune." To Forbush, there was no middle ground: they must either fight until victory had been won or quit the field. He dismissed the option of containment as "nonscientific": "I leave it for those who believe it is the wisest policy for the State to adopt [the course of containment] to estimate what the annual appropriations of $50,000 would amount to from now to the end of time."[56]

By the end of 1896 and for the rest of the decade, the annual reports of the gypsy moth committee took on a predictable pattern: the extermination effort was said to be achieving its aims (a statement supported by tabulations showing ever increasing numbers of insects killed, egg masses destroyed, trees banded, and woodlands cut or burned); extermination was assured within another few years, even though new colonies were being discovered all the time (additions explained away as being caused not by any deficiency of the effort but by inadequate surveying in consequence of a chronic shortage of funds).

By the time the year ended, some of the tumult had died down, and things were returning to normal within the gypsy moth organization. The committee offered to lighten the burden on Fernald by increasing the duties of Archie Kirkland and by having both Kirkland and the committee go to Amherst to consult with Fernald there rather than in Boston. After some delay for reflection and a lot of lubrication from the board, Fernald, with undisguised reluctance, once again withdrew his resignation. His decision greatly relieved the

committee; as Kirkland wrote him late in December, reporting on the last committee meeting of the year:

> Mr. Sessions . . . spoke of the tiresome trips you had to take and of the value of your services and of the necessity of retaining them by making it as easy as possible for you. . . . Mr. Wood spoke of the cost of the Insectary and that it would be a loss [should you resign]. . . . Mr. Pratt said "as long as the professor was good enough to withdraw his resignation last summer we ought to accede to any plan that he thinks will benefit the work or make it easier for him." It would have done you good to have heard some of the things they said about you in the discussion.[57]

Fernald's control over the campaign thus became absolute, for the Board of Agriculture and the gypsy moth committee felt helpless without him, and the thought of losing his services frightened them so deeply that they allowed him to do whatever he wanted: to disregard infectious diseases or imported parasites as possible weapons; not to petition the General Court to revise the extermination law were all policies he advocated. His contentions that extermination was only a matter of time and money, that if small areas could be cleared so could large areas, and that the state's only options were to exterminate or not to exterminate ruled the thinking of the board.

The year marked a turning point for Fernald personally as he realized that removing himself from his duties as adviser was now out of the question. He had made himself the guiding and indispensable force behind a war that could not be won and could not be lost, and the more he tried to escape, the more he was drawn in. The college had appointed R. S. Lull to assist him at the experiment station, eliminating Fernald's argument that he did not have enough time to do all his work. The genie of remorse and doubt that had visited Fernald at the seventh annual entomologists' meeting the year before seems to have been put back in its bottle, and there are no more reports that Fernald sought to resign or in other ways to be relieved of his duties after this time. In his annual report, he noted that everything that could be done with the amount of money available had been done. He called on the General Court, with language that he would use for the rest of the campaign, to make up its mind whether it wanted the committee to exterminate the moth, hold the moth in check, or abandon moth work entirely. Other options were no longer considered.

Fernald also convinced himself that his knowledge of the gypsy moth was encompassing, and he boasted to Scudder, "I think an examination of the

literature gone over [in the monograph] together with the attention I gave the subject the summer I was in Europe will convince one that I have the condition of this moth in Europe pretty well in hand."[58] Fernald was apparently unaware of the work of Austrian entomologist Fritz Wachtl and his colleague Hans Kornauth, published in 1893, which showed how a special growth of hairs on the first instar larvae of the nun moth (*Psilura monacha*) allowed the insects to be borne by the wind over considerable distances.[59] These "aerostatic" hairs, as they were then called, sprouted from hollow, globelike growths called "aerophores" on the larva's back. Wachtl and Kornauth noted that gypsy moth larvae in their first instar grew the same type of hairs and hollow sacs, and concluded that they also would be carried by the wind much farther than had been previously thought. This and the number of eggs in a mass were the two missing pieces of information that would have allowed the gypsy moth committee to understand why moth colonies were constantly found in unexpected places.

Regardless of the celebration following the hearings in February and March, the reduction of their gypsy moth appropriation by half was a warning to the Board of Agriculture that opinion in the General Court was still running strongly against them. During meetings in the fall, Sessions sounded the entire Board of Agriculture members to learn what they thought of the moth work. The feeling of the moth committee was that the General Court was very displeased, that its enemies in the legislature were getting stronger, and that cessation of appropriations was imminent. The committee decided "to strike the legislature as soon as it convenes for an emergency appropriation and test the sentiment."[60] The committee also decided to retain about $9,000 at the end of the year to cover any expenses for closing down the work and to pay off any outstanding debts.

[CHAPTER 13]

A Moth Too Many (1897)

THE GYPSY MOTH COMMITTEE reported a balance of $8,849.85 at the start of 1897 but expected to use the money to shut down all fieldwork.[1] This was the last year state commissions were permitted to retain funds for more than twelve months. New state laws required the complete expenditure of allocations in the same year they were made, although work could continue for the month of January until legislative action was taken.

The General Court held hearings on the gypsy moth appropriation in mid-January, a month earlier than usual. Unlike the previous year, this time nobody showed up to argue, not even the Frost brothers. The absence of a single adversary disturbed the representatives, several of whom directed the court clerk to ascertain whether notice of the meetings had been published.[2] On January 29 the appropriation was debated in the house, with opponents and proponents divided along geographical and political lines. Whatever their differences, many elected men expressed concern that the federal government had again declined to help in the fight.

Members of the house from the western districts of the Commonwealth opposed the bill, as did a group of representatives who were concerned about the growing debt burden of the state and questioned the ability of the gypsy moth committee to handle large appropriations wisely. Supporters included representatives from badly infested areas and politicians from Boston who liked the jobs the moth program provided their constituents. Representative Sanderson of Lynn recalled seeing egg masses on uncounted hundreds of trees worked on by a handful of men because there was not enough money to hire more, and he scolded his colleagues:

> The general idea among members from the western part of the state is that [the matter] is a sort of a humbug. I wish to say to them that when they have something more to contend with than a canker worm, a tent caterpillar, or a woodchuck coming out and eating up a cabbage, they will give some attention to this question. The gypsy moth

> is a reality and if any member does not believe it, he can easily find the workings of it within an hour's ride of this state house.[3]

The Massachusetts Society for the Promotion of Agriculture, a group opposed to the gypsy moth campaign, engaged the services of John B. Smith, the short and portly state entomologist of New Jersey, to refute the possibility of extermination. The society somehow had been duped into believing that Smith could be objective and was likely to support their opposing view.[4] They had even agreed in advance to publish Smith's findings, no matter what they were.

By some odd chance, Fernald was in Boston to inspect the field and consult with the Board of Agriculture when Smith arrived. In another astonishing coincidence, it just so happened that Leland Howard and Charles Marlatt were also in Massachusetts, ostensibly to get an early start on their report for the federal government. The jovial Smith, a phalanx of his colleagues augmented by William Sessions and several members of the moth committee, spent ten happy days in Massachusetts gathering facts. Given Smith's well-known gregarious nature and his "truly Teutonic fondness for beer," one cannot imagine him pining his evenings away in solitude, bereft of the companionship of his fellow entomologists.[5] As was their custom, these brethren of the net likely gathered at the end of the day in the hotel restaurant or one of their rooms to hash over events, practically guaranteeing that Smith's report would stick like glue to the goals of economic entomology. It should have come as no surprise that Smith expressed enthusiasm for the concept of eradication and endorsed it heartily while raising the usual concerns about financial support.

Despite his "great sense of humor," however, Smith was no fool.[6] He had originally followed a career in law but abandoned that pursuit to become another of the era's self-taught entomologists. His legal training had doubtless made him aware of the term "collusion," and the generally supportive tone of his report was tempered by the recommendation that insect enemies of the gypsy moth be imported from Europe. This departure from the standard line can be viewed as a subtle recognition that manmade efforts alone could not accomplish the task of extermination. The gypsy moth committee immediately diminished the force of Smith's argument by opposing the idea as "problematic" but hastened to add they would gladly take up such work if the General Court provided more money.[7] The Society for the Promotion of Agriculture, although completely flimflammed, kept its part of the bargain and published Smith's findings in several local newspapers, an event in which Fernald, Howard, Marlatt, economic entomologists, and the gypsy moth committee took great delight.

Public Relations

Smith's opinions and the glowing reports from the gypsy moth committee could not hide the realities seen by every citizen in the infested region. The efforts of the entomologists to represent themselves as bona fide experts on everything from ornithology to the safety of insecticides to the practices of forestry were unconvincing. The entomologists had no idea how to win over the public, and the more they tried to sell themselves as the great hope of the Commonwealth, the more foolish they looked. Forbush and Fernald seemed baffled that the average citizen was not nearly so enamored of killing insects as they were or had grave reservations about the liberal use of arsenic in residential areas. When pronouncements by men such as "Professor" Riley were made about the safety of arsenical sprays, Forbush and Fernald simply could not understand why no one believed them.

The sensationalist tendencies of the press were being put to good use by the opposition in discrediting the gypsy moth leadership. The management of the campaign loathed the tone of the press, especially when it was turned against them. The idea of brawling with the public through the newspapers was abhorrent to them, but the voices of opposition could not be allowed to go unanswered. After attempting a goodwill campaign of sorts and using the stature of other entomologists to bolster their claims, it finally occurred to the committeemen to fight fire with fire. What they needed was a good public relations specialist to strike a little fear into the hearts of those less knowledgeable.

The work of a local writer, Fletcher Osgood, on the municipal water system of Boston, published in the *New England Magazine* in 1896, attracted their attention, but the committee's mandate left no opening for the employment of propagandists. Osgood was thus hired and trained like any new employee and went on the rolls as a special agent. His occupations included journalist, gypsy moth agent, teacher, and justice of the peace. Although his skill as an insect warrior probably was no worse than that of the others, his skill with words was used to quash the arguments of an ignorant citizenry. He escorted politicians and other notables through the work zones, glibly countering any tendencies on their part to believe that the work of extermination was ineffective. Osgood had bigger plans than just filling out bug reports, however. He quickly ingratiated himself into the upper echelons of the office and by early 1897 had become Forbush's personal secretary.

Osgood's flair for overexcited writing was typical of the times. His first piece on behalf of the committee, "A State in Arms against a Caterpillar," was published in *Harper's Magazine* for August 1897 and began: "The State in

arms is Massachusetts; the caterpillar, a hairy creeper, spinner and cruncher, soot-gray in ground color, dotted with crimson and blue. When full grown he is thick and long as a pill-phial. He is hardy and appallingly prolific, and he is named the gypsy caterpillar, child of the gypsy moth."[8]

Osgood's breathless prose went on in an alarmist vein to restate the familiar theme of the stench given off by decaying caterpillar corpses and warned his readers that if left unchecked, the gypsy moth would devour every living plant in the United States within eight years:

> Let the "gypsy" once get free of the bounds within which, as we shall see, the State of Massachusetts has up to this time confined him; let him then multiply according to his nature, and not only would all our fruit and field crops go down before him (tobacco very doubtfully excepted), but the shade upon which depends our water supply would be more seriously threatened by this creature than it is now by forest fires or the woodsman's axe. The water supply of many districts, too, might well suffer extreme pollution by dying hosts of caterpillars.[9]

The effect of Osgood's efforts was not what the entomologists had hoped. Over time, the committee did better with the large newspapers of Boston by dealing with the most prominent editors. The committee also discovered that newspaper reporters would print almost anything they were given about the gypsy moth campaign, often after only the most cursory field inspections or a meeting in the board's offices. It still galled the committee and the campaign leadership, especially Fernald, when stories with sensational headlines were published, but by the end of the decade all four of Boston's major dailies had given their editorial support to the gypsy moth campaign.

The *American Naturalist* magazine, however, published in Salem, Massachusetts, had for years opposed gypsy moth work in reasoned editorials. The frequency of such writings increased at this time, providing a highly credible opposing view to the claims of economic entomologists. And newspapers and magazines outside the Commonwealth, beyond the reach of the committee's public relations men and not directly affected by the issues of politics and jobs, were more detached in their reports. The *New York Times*, for example, said of the war in Massachusetts that the "remedy [was] worse than [the] disease."[10]

The War Drags On

The General Court remained divided on the subject of extermination, and the appropriation of $150,000 made available on February 26 passed by only

three votes. Although the sum was only 75 percent of the amount requested, it enabled Forbush to make an early start. Men worked from the beginning of the year, and by the first of April tremendous amounts of underbrush and dead wood had been removed. There were 354 men on the rolls, concentrated in the infested sections of the Middlesex Fells in Medford, the massive Saugus Woods colony, and the Mystic Woods. By the end of May the trees in all these infested areas were wrapped with burlap.

Work in the Fells again brought the gypsy moth committee into disagreement with the Metropolitan Park Commission. The park commissioners had second thoughts about their policy of cooperation because gypsy moth gangs tended to commit such blunders as spraying arsenic on patches of edible berries inside the reservations or felling specimen trees. On April 7, Secretary John Woodbury of the MPC sent Forbush a set of seven regulations governing moth work in the reservations. Only dead or decaying wood could be cut and burned at times and places designated by the park superintendent and in his presence. The gypsy moth committee was instructed to pay the park official for his time. Living growth could not be cut except by special permit. Spraying was allowed only if it did not endanger life or foliage. Warning signs had to be posted in advance, and plants bearing edible fruit could not be treated at all. If stone walls were torn down, the committee would pay the cost of restoring them.[11]

Flooding stone walls with crude petroleum oil to kill the egg masses was tried in the park, eliminating the need to tear the walls apart and rebuild them. The raw oil was pumped through the cyclone burner and sprayed on the surface, seeping into and killing the eggs laid there. Burlapping continued in the woodlands, and spraying was done when weather permitted. May and June were abnormally wet, ruining Fernald and Kirkland's plans for large-scale tests using various formulations of waxed Paris green and barium arsenate.[12] The war effort had achieved a precarious balance with the insects, but then an unexpected turn of events changed everything.

A Moth Too Many

On May 8, Joseph B. Pike of Somerville reported an unusual defoliation pattern on his pear trees: caterpillars were consuming the leaves from the top down. Agent Osgood made a cursory investigation and at first reported that the insects were tent caterpillars. He later instructed Pike to collect some specimens and spray his trees with arsenical poisons: "I examined one day a small estate in Somerville, finding no trace of the gypsy moth about it. Members of the family occupying the estate assured me, however, that they had been troubled by a strange caterpillar which had assailed their pear trees and these only.

[Mr. Kirkland], the assistant entomologist of the gypsy moth department was unable on the meager data I could furnish him to identify this caterpillar . . . even when I sent him a bottle of [them]."[13]

A second complaint was received on May 14 from Roland Thaxter of Harvard that his pear trees too were being defoliated from the top down. This roused Kirkland to visit Cambridge and collect specimens. The caterpillars reminded him of a European insect called the brown-tail moth (*Euproctis chrysorrhea*.) In a hastily scrawled letter to Fernald on May 22, Kirkland asked: "Is not this insect Liparis Chrysorhoea [sic], the "brown-tail"? . . . Professor Howard was out with Minott yesterday and was unable to place it. I have compared it with Ochsenheimer and it seems to tally. . . . Osgood is ready to rush into print about it. . . . The people are alarmed and complaints are coming in thick and fast."[14]

Fernald came at once, and he and Kirkland began to investigate where and how the brown-tails arrived. They worked circumspectly, fearing public reaction to another invasion by a foreign insect. Citizens in Somerville told the two sleuths that a caterpillar fond of pear trees had been a nuisance since 1892, but many had already discovered that if the nests were clipped off the branches and burned during the winter, the insect could be controlled with ease. Fernald and Kirkland guessed the brown-tails had been in the state since 1890, and by following the instances of increasing damage to the center of the worst defoliations, they came to a florist's shop in Somerville. They learned that the business had imported roses from France and Holland until 1890, raising them behind their greenhouses before selling them. The brown-tail was common in France and Holland where it was a pest of roses. Roses were shipped in cold weather when the plant and its insect passengers were dormant. When the men walked behind the greenhouses, they saw two blocks filled with pear trees—a perfect habitat for brown-tails. This clinched the case, at least circumstantially, and Kirkland later called the appearance of the brown-tail in the same place as the gypsy moth "a strange fatality."[15]

Although the gypsy moth is not found in European literature until the middle of the eighteenth century, references to the brown-tail occur two hundred years earlier. Linnæus listed it as a silk moth in the genus Bombyx, the same one in which he had placed the gypsy moth.

The brown-tail outbreak was not large, but the damage was considered as bad as anything the gypsy moth had done and left the land looking as if it had been "swept by fire."[16] Residents in Somerville who tried to hand-pick the brown-tail discovered that the larvae packed in their "nettling hairs" a poisonous sting that sent some people to the doctor. One resident remarked that the fence and gateposts of her driveway were so thickly blanketed with larvae that "they looked as though they were covered with fur," but added that no one

dared touch the gates all summer.[17] Mrs. D. C. Chase of Somerville wrote: "While cutting the limbs from the infested trees my husband was badly poisoned, his eyes in particular being affected. In cleaning the window screens in the house I was also badly poisoned; the skin of my body was much inflamed as if a mustard paste had been applied."[18]

The McGarr family of Somerville suffered more than most, at one point being forced to abandon their house. The brown-tail nettles would even attach themselves to washing hung on the line; Mrs. McGarr said that when her husband put on his clean flannels, "they made him almost crazy." Other health problems in the household were even more serious: "The doctor who was called in to attend my mother said [the caterpillars] had poisoned her blood. [My mother] grew worse and finally died of this poison about the middle of August. . . . My son was also taken quite sick, and finally became so ill that he also had to be removed from the house. . . . I have never entirely recovered from the effects of the poison."[19] Fieldworkers too were affected by the poisonous brown-tail, especially when attending burlaps, and a number of casualties occurred.

The eggs of the brown-tail hatch and the larvae commence eating about the time the gypsy moths pupate. After about a quarter of their life has passed, brown-tail larvae spin communal cocoons of several hundred individuals and pass the winter in a suspended state. The larvae emerge in the spring two to four weeks before the gypsy moths do, and eat the tree buds before the leaves open, and following that, the flowers of fruiting trees, and, if available, the fruit itself and the twigs from which it hangs.

War on Two Fronts

While Kirkland and Fernald tracked down the center of the brown-tail invasion, gypsy moth larvae were hatching. Some trees had been banded with "insect-lime," a sticky substance that prevented the caterpillars from crawling up the trunk. To everyone's surprise, the formula used this year was most effective: many larvae starved to death because they could not cross the band, and the remainder were so weakened they were easily destroyed by fire. The early spring was unusually rainy, and the precipitation produced a lush growth of foliage. Burlap bands were not effective since food was abundant, and in the absence of sunlight the gypsy moths did not need to hide. Workers in the forest discovered that jarring smaller trees caused the larvae to fall to the forest floor or spin down on strands of silk. The crews would move on, and the gypsies would attempt to crawl back up the tree trunks and hide beneath the burlaps, where they were squashed by a second wave of crews.

In the Middlesex Fells and other areas of woodlands, the workers en-

countered gypsy moth larvae in great armies that covered hundreds of square feet of the forest floor with a hairy, black blanket. Contact sprays were used, or the ground was swept with fire from the cyclone burners, raising clouds of dark, foul-smelling smoke. Outside the Fells, where the egg masses engulfed the tree trunks, the trees were cut down and burned, eggs and all. Counting the dead was out of the question, and time was of the essence, both with regard to the spread of the insect and the depletion of the budget.

Insects in the woodlands occurred in isolated colonies, but to find them, workers had to inspect all the woodlands several times. The most experienced inspectors were entrusted with this work, which they did by forming men into a line and spacing them about one hundred yards apart. The men would trot through the forest, trying to spot egg clusters or insects. A few egg masses or a dozen feeding larvae were enough to indicate the presence of a colony, and after the location was noted, a second team returned for a more detailed inspection.

On May 25 the gypsy moth committee gave written notice of the brown-tail to Governor Roger Wolcott, and two days later Fernald and Kirkland delivered additional information to Wolcott personally, assisted by Leland Howard, who with Charles Marlatt had been inspecting Massachusetts for the federal government. The deadline for presenting new business had passed, so Wolcott sent a message to the General Court, which referred the matter to its ways and means committee. This committee allocated $10,000 against the brown-tail by deducting the amount from the gypsy moth appropriation. The bill was defeated, however, and a separate request for $6,000 to fight the new pest was adversely reported out of committee on June 8. The legislature at length passed a bill introduced by Albert Clarke of Wellesley requiring local authorities to suppress the brown-tail at their own expense. The legislation was even more draconian than that for the gypsy moth and showed that the General Court had learned nothing about the nature of such problems. Sections 3 and 5 of the act compelled owners of infested premises to put themselves under the direction of state authorities to combat the moth at their own risk and expense and subjected them to fines and incarceration for not complying. Section 4 provided financial penalties for mayors and aldermen of cities and selectmen of towns that refused to obey.

The center of the new infestation occurred along the Fitchburg Railroad tracks at the Somerville depot, and Forbush sent some men to spray the area with contact insecticides. On June 24 the Board of Agriculture ordered the mayors of Cambridge, Everett, Malden, Medford, and Somerville to take measures against the invaders. An inspection discovered more than fifteen infested communities, but there was not enough time or money available to undertake

effective work. The brown-tail moths emerged from their pupae during the first week of July and flew away, and a discouraged Kirkland wrote to Fernald: "Bad news. The brown tail females fly well. Not a strong flight like our butterflies but a slow whirring flight like that of the tent caterpillar moth. . . . Took some females today and by letting them go they flew about the room after the most approved style. The male flight is strong like that of the gypsy."[20]

Both sexes of the brown-tail are nocturnal fliers and soar where prevailing breezes aid their dispersal. Strong southerly winds reaching forty-eight miles per hour occurred in New England on July 14, 15, and 16, and within a few days the brown-tail was blown into New Hampshire. On July 19, Kirkland went to Somerville to spend the night examining streetlights. He found that both males and females were drawn to the glowing lamps: "The Electric Light Company employees tell me that they often find from one to two quarts of moths in the lamps. Another interesting feature is the fact that the toads, which assemble underneath the lamps, devour the wounded and fluttering moths. Thus, between the lamps and the toads, something like a clean sweep is made."[21] Kirkland also reported that flocks of English sparrows followed the fence lines where the imagoes hid during the day and consumed them in great quantities.

Since the General Court had charged the Board of Agriculture to oversee work against the brown-tail without providing financial support, Sessions used money from the incidental fund to notify communities and undertake inspections, which caused criticism of him and the board. Ultimately, the burden fell on municipal authorities, many of whom simply passed the buck to their local police. At the end of July, Forbush fell ill and was moved to the hospital in Worcester. Fernald was vacationing at his ancestral estate at Southwest Harbor, Maine, when Kirkland wrote him with the news: "Sunday of this week Mr. Bailey visited the Worcester City Hospital and saw the Director. . . . I infer that the Director has been in a much worse condition than the doctors report. It seems he has a serious stoppage of the bowels, which complicates his condition."[22]

During the summer the number of gypsy moth fieldworkers approached four hundred, but by August the shrinking budget dictated a reduction of 125 employees. The remaining workers were sent to scout, but about ninety remained in the Middlesex Fells creosoting gypsy moth egg masses. A two-year-old colony was found at Lincoln outside the boundary of 1891, but Forbush insisted it was destroyed by the time his men pulled out. In early September, Forbush, now recovered, ordered a two-week hiatus in the work, recalling his men on September 20 and sending them into the Saugus Woods and Malden.

In the Fells they worked so hastily that the usual records of destruction were not kept. Even the practice of ringing the treated egg masses with paint was discontinued; only a single mark was made on each tree to indicate that it was infested. Forbush wryly noted the savings to the state in time not spent tabulating results and in the cost of white paint.

Killing Chemicals

During the year the state used three tons of lead arsenate, purchasing the chemical components from Wm. H. Swift & Company in Boston. The two principal ingredients were acetate of lead and arsenate of soda. The mixture was prepared in the warehouse to meet the need for fresh batches in the field. Chemist F. J. Smith used calibrated ballast blocks on one end of a balanced beam and hung on the other end a cloth sack that he filled with the chemical until the beam balanced. The sacks were labeled and tied together in pairs, one of each chemical. Two men could prepare half a ton of poison daily in this way. When spray rigs went into service, pairs of sacks were carried along to replenish the tanks.

In the field, the ingredients had to be dissolved separately because moisture in the air caused an unwanted reaction when dry salts were mixed together. Each spray wagon was equipped with two ten-gallon kegs, which were filled from hydrants, wells, or streams. Where possible, the kegs were warmed in the sun, after which a sack of chemical was immersed in the water for fifteen or twenty minutes. After the salts precipitated out, the keg contents were poured into the main tank, and water was added according to a ratio provided by the chemist. Machinist E. C. Ware devised a twenty-five-gallon tank of galvanized metal using a lightweight Johnson pump, and machinist John Hancock developed a three-headed nozzle capable of delivering a cone of poison mist sixteen feet in diameter at a distance of eight feet. Kirkland reported that under the most favorable conditions, lead arsenate killed up to 80 percent of gypsy moth larvae, though normally the percentage was half that or less.[23]

During the campaign there had been public concern about the dangers to animals of arsenical spraying. When the threat to people was debated, it was entomologists and chemical company representatives who contended that the sprays were safe. Claiming that the press frightened the public with sensationalized stories of supposed cases of arsenical poisoning, the committee attempted to prove its point by noting that only one in every ten men on the spraying wagons "suffered more or less from arsenical poisoning."[24] Kirkland had been detailed to investigate this subject, a task that had occupied him for

nearly a year, and during 1896 he had examined some workers who appeared to be poisoned. Most of the spraying crews and nozzlemen refused to provide Kirkland with urine samples, but in June 1897 he collected eight samples and delivered these to Moulton for analysis. Moulton found varying levels of arsenic in six of the eight samples, leading Kirkland to understate that "in some cases men engaged in spraying acquire dangerous amounts of arsenic."[25]

Some of the men who exhibited little or no arsenic in their urine still complained of loss of appetite, biliousness, and digestive tract disturbances, all classic symptoms of arsenical poisoning. Kirkland believed that the odorous acetic acid used in the manufacture of lead acetate often made the men anxious and caused them to become nauseated. He also theorized that much of the problem could be attributed to the "complete indifference" of the men toward the dangers of working with poison. Handling and spraying pesticide had become an ordinary task, leading workers to relax their alertness, and since they had been selected for their physical fitness, they had come to feel impervious to the poison. Kirkland noted one case where a careless worker allowed spray residues to trickle down the pole and along his arms, soaking his entire upper body with arsenic. Such cases were likely the exception, but all men who handled nozzles absorbed arsenic to some degree.

Kirkland found a lame horse going to slaughter and persuaded its owners to feed it arsenic-soaked hay to simulate contaminated grass. After a few weeks, Kirkland reported, he was amazed to find the horse's condition actually improved. No such misconception was present two years later when the committee's chemist, F. J. Smith, was asked to analyze milk and urine samples from a cow that had eaten grass beneath sprayed trees. Smith was horrified to find that the family's children had been given milk from the obviously sick cow, saying that he "should not dare give such milk to young children."[26]

During the period of Kirkland's investigations, the medical community in Boston and knowledgeable men at Harvard were engaged in a bizarre debate as to whether arsenic in low doses was actually beneficial to humans: increasing sexual drive, promoting weight gain, improving complexion, aiding blood circulation. Four Harvard physicians—Frank Winthrop Draper, William Barker Hills, James Jackson Putnam, and Frederick Cheever Shattuck—published papers warning of the danger of prolonged exposure at low levels, and legislation restricting arsenic in the Commonwealth had been attempted without success since 1872.[27] The industrial use of arsenic was widespread, and the poison was also a common pigment for green-colored products of all kinds, including United States paper money! Although the State Board of Agriculture was heavily promoting the use of arsenic in the gypsy moth program, it is one of the odd juxtapositions of those times that certain of its members, led by

Appleton, were active in attempting to ban arsenic in other forms of commerce.

A number of medical practitioners remained convinced that arsenic could not pose any threats to humans unless it was deliberately abused, and many continued to prescribe it for medicinal purposes. These doctors often attributed some of the milder symptoms that Kirkland observed in the gypsy moth men, such as digestive upset or general anxiety, to other causes. Since the early symptoms of arsenical poisoning include a sense of greater energy, the apparent vitality of the spray men may have been a symptom of arsenical poisoning, as likely was the improvement Kirkland noted in the lame horse.

The medical community in general, by its own choice, remained outside the debate over the danger of exposure to arsenical sprays, leaving the field to entomologists, agriculturalists, and business entities that promoted the commercial use of arsenic.[28] Not surprisingly, the opinions of these groups tended to minimize the dangers of chronic arsenical poisoning, and their assessment of the lowest harmful levels of arsenic was anywhere from ten to one hundred times greater than those assumed by concerned physicians.[28]

On August 12 the Association of Economic Entomologists held its ninth annual meeting, at the Central High School in Detroit. Controversy swirled around the young organization, much of it caused by the arsenical spraying programs in Massachusetts. In a rambling address to the membership, President Francis Marion Webster warned that the trend he saw developing disturbed him because it prevented the organization from broadening its research and moved it toward spraying chemicals as the single answer for all problems: "I question the propriety of including the spraying of crops in the domain of economic entomology, as I believe it properly belongs with horticulture and agriculture. In other words, I question the right of an economic entomologist to demand or expect that he shall be allowed to devote the major part of his time in this manner."[29]

Horticulturists and arborists, in a strange parallel to the medical doctors, remained largely on the sidelines during the early days of the war against the gypsy moth. Slow to understand that spraying had an impact on plants as well as insects, these groups deferred to the entomologists. The fallacy in treating forests as another kind of farm had not yet become clear, and there was a lack of countervailing expertise in this area. Massachusetts would not create the office of state forester for another ten years, and during this period the only groups that spoke out against spraying with any force were the market gardeners of the Boston region and the citizens of heavily sprayed communities. Since neither of these bodies was well organized, both were overshadowed by the supposed expertise of the economic entomologists, who largely had the field of pesticide safety to themselves.

Leland Ossian Howard, circa 1886.
Special Media Services Division, National Archives & Records Administration.

The Many Opinions of Leland Howard

In July the U.S. Congress funded an investigation of the situation in Massachusetts, and Leland Howard wasted little time preparing a pamphlet that was published in November. He lifted most of it from the monograph of 1896 and added a few personal observations. He took everything related to him by Forbush and Fernald at face value, put it in the best possible light, and used the publication to commend the progress of economic entomology. He traveled to Massachusetts four times in 1897, making his first trip in May with Marlatt. His September visit was to ascertain the condition of the infested region, and the visits of July and November were used to interview individuals who opposed the eradication program.

Howard's praise for the work of his fellow economic entomologists gushed like water from a ruptured main. He crowed that gypsy moth extermination was approaching, and the few insects remaining in the Lynn Woods should not be feared. He opined that any part of the park could be freed of the moth in a short time, that colonies everywhere within the boundary of 1891 had been reduced to insignificance, and that small errors of the past, such as overlooking a straggling colony, were unlikely to happen again. He exulted that no further work ever would be required in Waltham, and that there would be no difficulty clearing Woburn, with the assurance of someone counting his chickens before they hatched. At times Howard's eagerness was embarrassing.

The organization of the work was "perfect"; the interest of the employees was "vivid": the employees were enthusiastic about their "important" work; they dragged themselves to the job even when they were sick; and so on: "The effort of (Massachusetts) will rank as one of the great experiments in economic entomology in the history of the world. . . . No criticism can be made, even in the light of present experience, since it has been in the hands of the State board of agriculture. . . . [I]t is safe to say that, even at this time, the total outcome of the work has been of great value, not only to the country at large, but to all civilized portions of the globe."[30]

Howard knew that on several occasions the agriculture committee had taken statements of opposition from men of high scientific standing. He professed to be baffled by these contrary opinions, and his report omitted the names of the objectors and failed to mention their objections. He finessed his summation by saying not that he could find no one against the work but that he could not find a single opponent who understood the work.[31]

Declaring Victory

By November 10, most of the remaining men were working in the Medford woods, where, as Kirkland wrote to Fernald, there was plenty for them to do. Money remained for only two more payrolls, and the men were laid off in alternation so that the best could have partial employment for the rest of the year.[32] Most of the men were let go by the last week in November and the rest a week later, and afterward, Forbush stewed in frustration as the most beautiful December in memory passed without any work being done. The release of the field force provided a potential pool of expert men for efforts against the brown-tail, but their services went unused. Several jurisdictions and some private estate owners hired a few men, but most private property owners refused to participate, and local authorities refused to prosecute them.

The gypsy moth committee finished the year by announcing that the outer towns were in good condition, and that if the full request of $200,000 had been appropriated, all the colonies everywhere would have been cleaned up. The committee also stated that extermination of the moth was "certain," pending a timely disbursement of funds. Fernald, in his portion of the annual report, treated the extermination of the gypsy moth as a fait accompli—with the usual proviso: "Since all the experts who have carefully and fully investigated the matter believe extermination to be possible, and, as previously stated, we have already exterminated numerous colonies, many of them in the most unfavorable places and of considerable extent, there can be no question but that what has been done in one place can be done in another, and that the

extermination of this insect is possible, so that the result is dependent entirely upon the action of the legislature."[33]

The General Court did not share this assessment and was preparing to cease appropriations. The legislators were weary of providing large sums of money for moth eradication that was endlessly claimed to be possible and bearing the blame whenever something went wrong. The "imminent" destruction of the moth, as projected by the committee in its 1897 annual report, would take another ten years and cost an additional $1.5 million. Fernald had harped publicly for several years that if the legislature was unwilling to continue investment in the gypsy moth program, it should abandon the work, and the General Court was now inclined to agree.[34] But the gypsy moth committee survived another year because the appearance of the brown-tail moth had added a new uncertainty at a time when the legislature was not in session.

The committee and its field director ended 1897 in a curious mood of self-righteousness, bravado, and lingering doubt. The annual report was a mass of contradictions and conflicting evidence about developments in the field. The committee had been buoyed by what it thought was a great success in the woodlands, the one area it had feared to attack. Forbush believed that the work on the rock-strewn and cluttered forest floor was equal to anything ever done in the towns and cities, and he expected to find few caterpillars there the following year. Fernald believed that if he could not find any egg masses, then none were there to find. A feeling began to emerge within the leadership that the doom of the moth was impending and unstoppable—by anything except the loss of funds.

Forbush put his own reputation on the line by making a long and arduous personal inspection of all infested areas, concluding that more progress toward extermination had occurred in the last ten months than at any time before:

> [Extermination] is only a question of time and adequate appropriations. People who hold opposite opinions seem to be impressed by the belief that the gypsy moth is generally distributed over the whole so-called infested territory of more than 200 square miles. This, emphatically, is not the case, nor has it ever been the case. Outside the central towns the moth is found only in isolated swarms or colonies, separated by wide intervals of uninfested grounds. In fact, the greater part of the region called infested has never been invaded by the moth.[35]

Looking toward the coming battles, the committee declared that the Commonwealth now held the moth "in the hollow of her hand."[36] Forbush

announced that the time had arrived for the vaunted moth to get its due. Most of the infestations in the outlying towns had been eliminated, and any scattered survivors would succumb to inevitable death the following season. The danger of expansion past the boundary of 1891 had been removed. There was no longer any need to spread out the men, and in the spring the entire field force could be concentrated in the central towns. The moth would be pursued into every hiding place and ruthlessly expunged. Burning, spraying, burlapping, and crushing with steel brushes would be used without mercy until not a single gypsy moth colony, egg mass, or straggling refugee could be found in the state.

The long-sought victory would have to be bought before it could be won, of course, and the bargain price was $200,000 and not a penny less.

[CHAPTER 14]

Do or Die (1898)

State entomologist of Maine F. L. Harvey, had been watching the spread of the gypsy moth in Massachusetts with some concern. He knew about the discovery of the brown-tail there, but did not think he would have to deal with the newer insect first. But when Massachusetts inspectors, trying to ascertain the brown-tail spread that had begun in Somerville, called on George E. Osgood, a physician who spent his summers in Maine, they learned that the brown-tail was already out of the state. As Sessions wrote Harvey: "[Dr. Osgood] saw the brown-tail moth in South Berwick, Maine, while on his last summer's vacation, and was sure that it was identical with the Somerville pest. . . . [H]e professionally treated two cases of poisoning by contact with the moth and said that the symptoms of the patients were identical with those of his Somerville patients. . . . The premises in South Berwick are owned by the doctor's father-in-law, Andrew Whitehouse."[1] Early in 1898 Harvey wrote to Whitehouse, who thought the insects had been brought to Maine in winter nests on some roses bought at a Somerville nursery. Because his boy had been badly poisoned by the insects, he had cut down and burned all his infested vegetation.[2] Harvey could only wait and hope that Whitehouse had managed to destroy the colony.

In Massachusetts the San Jose scale was spreading beyond the thirteen communities where it first had been found. The board was focused on moths, but elsewhere the scale insect was the real terror to be faced. Unlike the gypsy moth, which had taken nearly thirty years to occupy an area of several hundred square miles in a single state, the scale became widely distributed in thirty-one states over a period of about ten years. Even entomologist John B. Smith of New Jersey, who proclaimed that the gypsy moth was the ultimate in terrifying insects, wrote in 1898 that research on the San Jose scale now preoccupied entomological work at every agricultural station in the country.[3] This information was no secret to Charles Fernald, who knew the scale had eclipsed both of the foreign moths but publicly maintained otherwise. In a letter to his son Henry, then working in Harrisburg, Pennsylvania, Fernald

advised, "The San Jose scale is the most important insect now in this country, and you should make a critical study of it."[4]

Do or Die

The gypsy moth committee planned to focus its effort for 1898 on the infested woodlands, including the Middlesex Fells, in the heart of the boundary of 1891. It was to be an encompassing effort with nothing held back, a do-or-die attempt to destroy the moths in these strongholds regardless of political and financial cost. The war had reached a decisive point, and it was becoming obvious even to the Metropolitan Park Commission that something would have to be done about the gypsy moth in the reservations. The commissioners had been slow to recognize the threat because the work of Forbush's men had shielded them from the gypsy moths at their worst, and as late as 1897 they still believed fire was the biggest threat to their new woodland parks.

One has only to look at photographs of typical conditions found in the Boston reservations, such as those in the Menotomy Rocks Park in Arlington, to marvel that extermination was even attempted by the means then available. Photos show nothing but crowded young trees as far as the eye can see, most of them no more then ten or twelve feet tall with trunk diameters of less than four inches. It still astonishes the viewer of more than a century later to contemplate that each of these trees would have to be individually inspected, wrapped with burlap, and then tended almost every day for eight or ten weeks. In addition, running among the shrubby growth in the large tracts there were often miles of loosely piled stone walls two or three feet in height. All these walls had to be pulled apart, each rock examined for egg masses or pupae, and then the walls rebuilt.

The year of the great attack began inauspiciously. The committee was disorganized, underfunded, and limping along with about 150 men. In Malden, Kirkland was working up a report on the Podisius predators with substantial help from Philip R. Uhler and Samuel Henshaw. Fernald was ill again in Amherst; Forbush was beginning to lay off his workers; and everybody was unsure about the disposition of the legislature. Rumors were flying that Governor Wolcott had turned against moth work, and the governor's annual message was awaited with apprehension.[5] A company of two hundred men was hired and sent to burn brush, cut trees, and destroy egg clusters wherever they were found in the Medford and Saugus woods. Forbush sent the entire eastern division of his field army, numbering about fifty men, to scout Saugus and vicinity. Special Inspector Taylor C. Lyford was in the company and was disgusted by the events of the day: "We were lined out and started in ten feet apart. When we got to the other end of the line some of the men were a quarter

mile apart, some 100 feet, some four, six, or eight, right into Lynn, a wild goose chase, going at a horse trot rate of speed. . . . I don't think one-tenth the nests in there were found. They could not have been. . . . There was not one tree out of 25 that even had a scout mark on it."[6]

When funds ran out at the end of January, work stopped and the men were dismissed. An emergency appropriation of $20,000 was made in February, and men were recalled to work in Melrose and Everett. The work continued in an atmosphere of odd normality; Forbush was making contingency plans for the spring; Fernald was recuperating; and gypsy moth committee meetings were occupied with routine business. Kirkland was speaking at farmers' meetings about the gypsy moth and taking members of the house agricultural committee on tours of the infested region. As always, he reported his doings to Fernald: "On Friday last I had Mr. Brisebee of the [agricultural committee] at Malden and gave him quite a trip. He talks as if [they] were going to take considerable time to consider the matter; this looks as if it might be June before we get an appropriation."[7]

At the end of the month the money ran out again, and the force was laid off in stages between March 11 and March 18. But contrary to expectations, the General Court did not indulge in long and rancorous hearings, stunning even the most supportive observers by granting the gypsy moth committee the entire amount it had asked for and passing the measure by a comfortable margin. Kirkland attended the final sessions of the legislature and reported to Fernald: "The house passed . . . our bill of $180,000. Two amendments of 150 and 125,000 [dollars] were offered, but the larger sum passed by a vote of 86 to 44. The debate was interesting; was on broad lines so far as friends of the bill were concerned. Opponents made free use of ridicule, slander, and abuse and lost their case."[8]

The full allocation did not become available until the middle of April, but the emergency allocation allowed the fieldwork to be carried out at full strength. It seemed the legislature intended to give the entomologists enough rope to hang themselves or prove they could exterminate the moths, the task the *American Naturalist* called "hopeless."[9] Forbush was less than grateful; the early appropriation still came too late as far as he was concerned: "Many experienced men had removed to considerable distances; some had found better jobs; and it was difficult in fact, impossible, to get them all together again."[10] By April 23, 322 men were prepared to work, but the caterpillars were already swarming. It was too late to burn or spray, so most of the men wrapped trees with burlap.

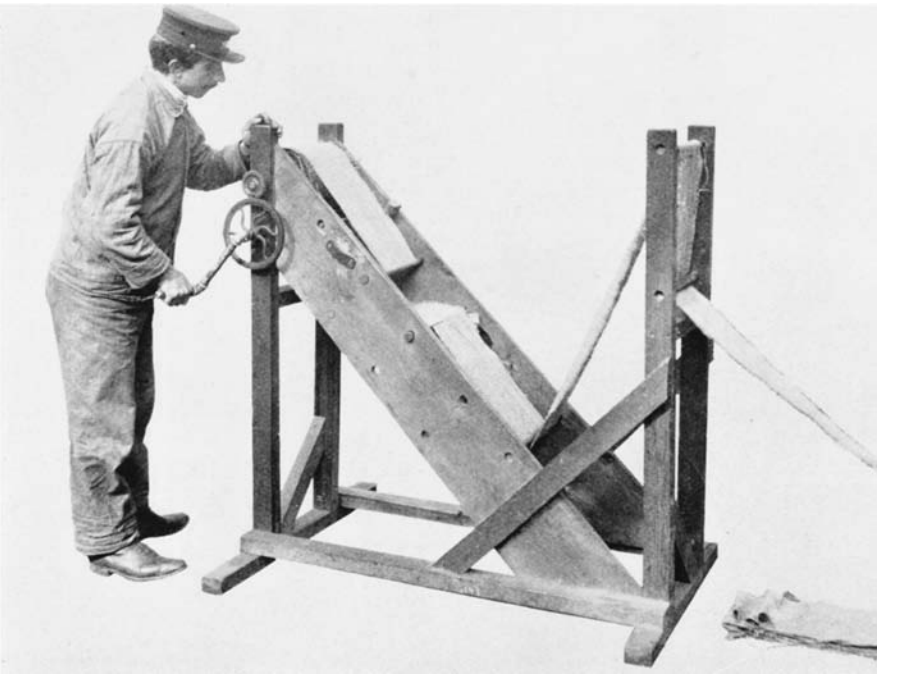
Meanwhile, the results achieved by individuals and communities fighting the brown-tail were so dismal that the legislature repealed the law of 1897 and placed responsibility for controlling the brown-tail with the Board of

Agriculture. The new law was worded like the gypsy moth act, but the penalties for uncooperative elected officials had been removed and placed instead on the citizens. Yet it mattered not a whit if anyone transported the insect, since it could get anywhere it wanted to go without help, and threats of imprisonment aimed at the ordinary townsman were senseless because even the entomologists did not believe the brown-tail could be eradicated. Obstinate estate owners were liable for fines of $200 or up to sixty days in the house of correction, or both, for failing to do their part. The legislature also voted to make all present and future employees of the moth committee take an oath of allegiance to the state.

Even with a substantial appropriation in hand, the gypsy moth committee made a great effort to economize so that every dollar possible could be spent in the field. The scientific corps borrowed supplies and materials from Fernald whenever they could and made what Kirkland termed "the best trade" for insecticides, which, Kirkland judged, saved the entire cost of arsenic compared with the previous year. Forbush reduced the office stenography pool to one person and embargoed the sole remaining typewriter so that Kirkland was obliged to write his letters to Fernald by hand and apologize, with good reason, for his sloppy penmanship.[11]

In addition to waiting for his annual appropriation from the state, Forbush also had to wait for the MPC to meet and vote on his requests to work in the Fells. In April he received a letter from the commission's secretary, John Woodbury: "At the meeting of the Board held yesterday it was voted to give your committee permission to burn over the ground in a few restricted localities in the Middlesex Fells Reservation under such supervision as is required by the Superintendent of the Reservation, the cost of said supervision to be paid out of the funds at the disposal of your committee. The work is to be stopped immediately if the Superintendent deems it detrimental to the Reservation."[12]

The concerns about fire were rendered moot by a cold and wet spring that spoiled last-ditch efforts to control the insects by spraying arsenicals or blazing the ground. Despite the reservations expressed about using burlap bands in woodlands, this method again proved the most successful, and the committee now planned the way it cleared woodlands so that larger trees were left standing to receive burlaps. It declared that the last two years had shown conclusively why burlapping was the most effective way of destroying gypsy moth caterpillars, and that without these bands the state forces would have been overwhelmed. Economic entomology, crippled by its limited arsenal of chemicals, was glad to have a dependable method to fall back on. It was a favorite technique of the committee because it drew little ire from the public, and it was a favorite of men in the field because it worked. One optimistic field



Burlap rolling machine.
From *The Gypsy Moth.*

assistant assured to Leland Howard that the last gypsy moth larva in the Commonwealth would be caught under a burlap band.[13]

During the battles of 1898 the committee purchased fifty-four bales of burlap and cut each one into 4,363 yards of strips a foot wide. In earlier years, each man had used a knife to cut his own strips in the field, but now a serviceable burlap-cutting machine was developed and constructed by E. C. Ware. A large, serrated knife similar to a hay knife was driven by an elliptical gear to slice the burlap, which was then tightly rolled on another of Ware's inventions, a man-powered burlap-rolling machine. Thus the committee was able to prepare miles of burlap for its own needs, using just a few employees. The compact rolls were loaded in high-wheeled carts and pulled into the woods by hand, ensuring that the men had ample supplies to work efficiently.

Hundreds of millions of larvae hatched that spring, and vast numbers of gypsy moth caterpillars issued from the Middlesex Fells, requiring between fifty and one hundred men to remain in Medford all summer. Another large contingent was tied down in Malden the entire season, doing nothing but

killing immeasurable numbers of caterpillars. Migrating swarms covered one house to its window frames; larger trees required three burlap bands to trap all the larvae; and all foliage was stripped from all shrub land around the city. Forbush ultimately committed two full "divisions" to Malden, nearly two-thirds of his available forces, and he even sent the cartographers, janitors, and mechanics from the field office into the fray. The gypsy moths had outflanked him again, and he mused that the insect seemed to "spring up like a mushroom in the night."[14]

E. C. Ware equipped his one hundred-gallon cyclone burner with a one-man pump that could supply up to six men. Lengths of iron piping and tee fittings were carried into the field, fastened to the tank, and laid on the ground. By connecting flexible hoses to the fittings, the men were then able to spray a considerable area, after which the iron piping was detached, the apparatus moved into a new location, and the process repeated. The new machine enabled crews to form skirmish lines and incinerate vegetation in a swath sixty yards wide. Ware's device, manufactured in the committee's own shop by machinist John Hancock, was not corroded by lead arsenate and needed no packing material because it was machined of brass. The simple and reliable pump fit inside the tank. The device was self-agitating and protected by a relief valve so that the hose would not burst. The key to its success was the availability of quarter-inch spraying lines, but Ware and Hancock had to design and build couplings that did not reduce the inside diameter of the tube. Having developed both a powerful insecticide and a greatly improved machine with which to dispense it, however, the committee was unable to do much spraying because the weather became unfavorably wet in the crucial month of May.

Burning was resumed when the weather permitted, beginning on two hundred acres partly lying in the Middlesex Fells. The super cyclone burners spewed for three months as the men worked back and forth through fields and forests until entire tracts in Medford and Malden had been burned to a crisp. Osgood noted that a thick pall of smoke hung over the region all season as woodlands, brush lands, vacant lots, and rubbish heaps were put to the torch.[15]

Because cutting the trees in the Middlesex Fells and other parklands was forbidden, every tree there had to be inspected every year, banded with burlap, climbed, and cleared by hand. The committee did not have enough manpower to undertake this task, so it hit upon a novel plan: if it could not cut down trees in the reservations, it would cut them down everywhere else, freeing men to work in the parkland. Chopper gangs were organized to cut away brush and fell trees on three thousand non-park acres throughout the infested regions.

Declaring Victory

Charles Fernald served as president of the Association of Economic Entomologists in 1898, and in August the members held their annual meeting in Boston. Speaking before the group, Forbush once again sounded an optimistic note: "In no previous year have we been able to speak so confidently of progress so early in the season. The great wooded tracts, especially in the eastern, western, and northern divisions of the infested territory, are now in excellent condition. More than ever this year I have been impressed with our power to cope with and in due time to utterly extirpate the gypsy moth when we are sufficiently supported by legislative grants."[16] About half a dozen members of the association treated themselves to an inspection trip of the boundary zone and the storehouse at Malden, after which they pronounced themselves entirely satisfied with the work and passed a resolution: "the work of the gypsy moth committee in the State of Massachusetts having been inspected in all its details by a large number of the members of this association, and its methods of operation observed, it is our opinion that too much praise can not be bestowed upon those who are carrying out this important work."[17]

These approbations carried little weight with the Massachusetts General Court, since economic entomologists were fond of passing this sort of resolution, and their objectivity was suspect. Further, the "large number" referred to must have been a relative one, given that the association at this time could not muster more than fifteen members for its annual meetings. Leland Howard was a familiar visitor who remained cheerful about whatever he saw. His name had been dropped so many times that it was somewhat the worse for wear, but it always had some effect because he was still the chief entomologist for the federal government—an institution that had little interest in what was bugging Massachusetts. Howard was in the field between October 7 and 14 and wrote Fernald to express his glowing admiration of the work and to praise the efforts of Superintendents Harris and Bailey in the Lincoln colonies. Howard urged Fernald to produce a monograph on the brown-tail moth, and with regard to the accomplishments of the year he said: "I cannot see how the most critical person could go over the ground now, especially if he had known the conditions of three years ago, without expressing entire satisfaction with the work which has been done and without being thoroughly convinced of the wisdom of the State's policy."[18]

There were other visitors to the infested zones besides economic entomologists. Whenever possible, committee members took influential state legislators on a tour, hoping that the beneficial nature of their work would be so evident that even untutored politicians could recognize it. Not all of these expeditions produced the desired results, according to Fletcher Osgood, who

often guided such less than memorable events: "I vividly remember that when one of Boston's well-known Senators came out of what was then known as the Saugus River gypsy moth colony in Saugus . . . I found upon his coat a sluggish gypsy caterpillar. . . . The season of the gypsy caterpillars had passed, and they had become so rare that the Senator at least seemed to have removed one of the only two caterpillars we had discovered in the colony that day."[19] And Senator Leonard Ross remembered being told " 'We will show you a case of extermination'; they took me to Brookline to Mr. Schlesinger's place. 'Here we have exterminated it; the last bug is gone,' and I said 'yes, but on the other side of the fence while you are hunting here is another colony.' "[20]

Senator Alfred Barker also had little faith in the explanations of entomologists because he saw them all as self-serving:

> They show [a man] around and say, why there were 15 tons of caterpillars here three or four years ago, . . . do you see any bugs? Why, the gentleman walks through there . . . and he does not see any bugs. There may be 10,000 of them in that acre and he does not see them. There may be eggs enough in that acre, gentlemen, to seed the whole Commonwealth, and he will not see one of them. They keep him there a day and a half, possibly two days, and when he has got through he says, "Why, yes, if you have exterminated them from this acre, you can exterminate them from ten acres; if you can exterminate them from ten acres you can from a hundred," and so on. "I guess they can be exterminated," and so they get his opinion [quotation marks added].[21]

The work of the chopper gangs was halted by snow on November 26, and progress was slowed by the bitter cold weather that followed the storm; most of the snow was still on the ground five weeks later. The end of the year came, and the committee ran out of funds before the choppers ran out of trees. On November 29 the entire gypsy moth field force, augmented by a large number of new hires under a different appropriation, was set loose on the brown-tail moth. The force of 524 men worked in the worst infested regions of Somerville, Cambridge, Medford, and Everett. More men worked in December than had been employed all year. Inspections were made, and of the original thirty-three infested communities, only seven were declared free of gypsy moths. Eleven new towns reported gypsy moths for the first time, but inspectors reported they could not find signs of moth activity anywhere except Manchester.

The committee was considering how much it could expect to accomplish against the brown-tail and decided to fob the matter off by asking for $10,000

to suppress the moth or $25,000 to exterminate it. Forbush considered that at least $50,000 would be needed in any case and wrote to Fernald that the committee had made a great mistake by not asking for enough money.[22] The work of the year had been concentrated in the forested portions of the zone, rather than the communities, and the directors of the field force were convinced that they had dealt the gypsy enemy a powerful blow: "Egg clusters are now in most cases rare and hard to find, even in localities where the caterpillars were killed by the millions only so recently as the past summer. In the Saugus woods, where the caterpillars taken in past seasons have been estimated at thousands of bushels, it is difficult to find egg-clusters today. In the woodlands of the Mystic valley, outside of Medford, the same condition prevails, and egg-clusters can now be found there only by long and tedious search."[23]

None of this meant much to Walter Wright, whose estate continued to prove vexatious. Wright promised a young boy five cents for each egg cluster he found. The boy worked all afternoon but had not found many eggs—until he came to a stone wall, separating Wright's land from a neighbor's, which a gypsy moth gang had burned out earlier in the year; in fact the land next to it had been blazed so severely that Wright said it nearly had been reduced to an open field. Yet in that 789-foot-long wall the boy found one hundred egg clusters. When the boy's father came by, he took a turn at the wall himself, found three hundred more egg masses, and scolded his son for not being thorough.[24]

The brown-tail moth was so different in its habits that Fernald, writing in the annual report for 1898, felt it should not be grouped with the gypsy moth and that it was unproductive to wage war on both insects at once. He chided the legislators for being so ponderous in their deliberations that by the time any of them could be convinced the brown-tail was a threat, it would have spread completely throughout the country.[25]

Fernald had vacationed at West Harbor, Maine, during the summer, constantly answering mail from Forbush, Kirkland, Sessions, and others. He was deeply disturbed when the news arrived that his old friend Joseph Lintner had died while vacationing in Italy. He and Lintner were considered the old guard, a group that was increasing in influence even while diminishing in number. Fernald was wearing down; his rheumatism was getting worse and he was increasingly prone to colds and flu. The requirements of his academic work and the continued demands of the gypsy moth committee made it difficult for him to finish anything. In a letter to entomologist Harrison Dyar shortly after he returned from West Harbor, he complained that to discharge his duties to the college, the insectary, and the gypsy moth committee he would need to be three men.[26]

As the trials of the year concluded and the moth committee began preparing its annual report, Forbush was working up a section on the newly developed spraying machines. But Kirkland was concerned that too much of the wrong thing said in the wrong way would hurt their chances for the next appropriation: "I question the wisdom of filling up the annual report to the legislature with technical matters . . . but still if [Forbush's] article is made readable and practical and shows that we are looking after economy in methods it may have a good effect. I hate to urge Forbush to write anything these days because the finished productions contain so much of Osgood's bluff and bluster."[27] Howard disagreed with Kirkland, and in November he reminded Fernald of the campaign's third agenda: to advance the cause of economic entomology through useful work, even if the people and the state seemed unimpressed: "Perhaps some of your committee, as practical men, may not see the importance of so much scientific detail, but you know as well as, or better than I do, how essential to the scientific credit of work is the published record of all its details, and also how often upon apparently insignificant scientific discoveries will depend ultimate practical results of great value."[28]

The park commissioners observed with concern the efforts of the gypsy moth field force in the Fells during the season. It became clear to them that the more work was done, the more work needed to be done, and they likened the drastic methods they witnessed to throwing kerosene on a fire. William de las Casas advocated a new approach:

> There has been an earnest effort, both on the part of the officers of the Board of Agriculture and the employees of the Commission, to avoid any friction in the performance of their duties; but the point of view of the object to be attained is necessarily so different that it seems desirable, if this kind of work must continue from year to year, that some arrangement should be arrived at by which this work should be done by the employees of the [Park] Commission, directed, of course, by competent persons.[29]

The Olmsted Brothers noted that the gypsy moth had been in the Fells since the commission acquired it but had stripped leaves only in a few localities each year, regardless of work done by the gypsy moth committee. The brothers had monitored fieldworkers all year, trying without success to devise a system that would allow both park commission and moth committee to achieve their ends. After observing the dreadful "petroleum blasts" of the cyclone burners and the resulting condition of the forest floor, however, and enduring the entreaties of Forbush to cut all but twenty or so trees per acre, the Olmsteds concluded that the work of the two groups was inimical: "We have assented, with

regret, to the cutting of the larger undergrowth in certain sections, knowing that it will spring up again from the roots; and we have protested, generally with success, against the total cutting, and burning of the smaller ground cover, which gives the forest-floor its charm. Except in some limited areas of severe infection, where everything combustible on the surface of the ground was burned by the petroleum blast (most of which work was not done under our inspection), we have prevented the destruction of any pines or hemlocks.[30]

At a meeting of the Board of Agriculture in Amherst on December 8, Sessions read aloud the committee's annual report and asked the board members to endorse it individually so that it would carry extra weight with the legislature. But although the report was endorsed unanimously, a number of board members were concerned about what was taking place in their name. William Bowker had written to Fernald in October to express his feelings that "if we would live happily and successfully we must put ourselves in harmony with [the laws of nature]."[31] And if the opinion of the legislators can be judged by votes in the General Court, about one in three was outwardly opposed to eradication efforts, and even among those who supported the undertaking there were serious reservations. Some agriculture board members had seen ominous warning signs, as Charles E. Parker of Holden said:

> I do not believe the [gypsy moth] appropriation bill would have gone through our Legislature last year if it had waited until later. I question whether the Legislature will willingly grant [another] appropriation, except the [federal] government takes hold and does its part. It has been said that we are not only working for Massachusetts, but for the United States; then why should Massachusetts pay all the expense? It seems to me that the gentlemen of [this] board are the ones to . . . get the [federal] government to appropriate $100,000, while Massachusetts puts in another $100,000. . . . It seems to me you should do this before our Legislature sits. I bring these thoughts to you because they are my strong convictions, and I believe now is the time to act.[32]

During this meeting, Sessions resigned as secretary of the board, although he retained his place on the gypsy moth committee.

Further scouting at the end of 1898 revealed that the brown-tail had spread to thirty-two additional cities and towns. Kirkland wrote to Fernald that the moth could be found from Manchester to Scituate and as far west as Waltham, and that there was no longer hope that the insect could be exterminated.[33] Fernald had become very sick again and had written to Harrison Dyar that he could continue working only "if my life and health are spared."[34]

Forbush marshaled all the men he could and sent them to cut down brush-

wood and undergrowth to make the areas ready for work the following spring. He was disturbed because work in the woods had not gone as well it needed to. He was disgusted with efforts against the brown-tail because they were a drain on his time, energy, and resources, and he thought even the idea of trying to control this fast-moving insect was absurd. He had come to the odd conclusion that Kirkland was maneuvering against him, and he was angry with Fernald over disagreements in the final report on the brown-tail. Forbush settled matters by washing his hands of the entire affair, as Kirkland added in his second letter to Fernald that day:

> On Wednesday night Mr. [Albert] Burgess met Mr. Forbush at the office, Mr. Forbush having previously arranged for the men who were working on the brown-tail moth to come to the office at that time. When they arrived, Mr. Forbush told them that he should turn over the entire brown-tail work to Mr. Burgess and would have nothing more to do with it. This, of course, was all news to Mr. Burgess, but he handled the matter in very good shape and has been in the field scouting with these men since that time. The work stopping for the year as it does today, I think that the whole matter will now blow over.[35]

Fernald, despite his prestige and the powerful influence he wielded, had become almost superfluous to the project. Control over the conduct of the war had slipped from his hands into those of Forbush, and his presence now merely dignified the process and maintained the facade of scientific credibility. The success of the conflict rode no longer on the discoveries of entomology but on the backs of a few hundred sweating laborers earning two dollars a day. Improvements came not from the laboratories of universities but from the hands of machinists, and the theories of economic entomology yielded to the methodologies of administrative detail.

It was not the gypsy moths that were fighting for their lives, but economic entomology. There was hardly a shred of science being applied in the field; even Kirkland's findings about arsenic additives did not influence the course of the war in the slightest, and Fernald's experiments might as well not have taken place for all the good they did. For a group of scientific men who were going to prove the value of applied work, almost nothing practical had been produced. Science seemed even more exhausted than the men who worked themselves into profound fatigue day after day under the hot summer sun. As technology and state-of-the-art experiments failed, leadership passed from detached intellectuals and scientific academics to men who, as Forbush said,

hunted the moth as a hunter hunts a deer—and whose mood moved closer to Dexter Rogers's view that scientific ideas were nice, but the only way to eliminate the invaders was to cut them in half one by one. The war reverted to a dreary fight in which a few hundred men armed with strips of burlap and small knives were sent into the field to confront billions of gypsy moths.

[CHAPTER 15]

Failure Is Not an Option (1899)

THE YEAR 1899 began with Kirkland shouldering many of the responsibilities normally handled by Forbush, who was "confined to his house by an attack of the grip."[1] The gypsy moth committee assembled on January 3 but enacted little business. Work on literature for the brown-tail moth halted because there was no money left, and problems with the San Jose scale were demanding more time from Fernald and his assistants at Amherst. Thanks to late appropriations, legions of caterpillars, and recalcitrant park commissioners, and despite the positive spin put on the events of 1898, the committee's forces had barely escaped a rout. The field leaders were in a grim mood, and in their annual report they protested being compelled to undertake a task for which they were never given sufficient funds.[2] The committee proposed that one last, unfettered effort be made to crush the enemy in the heart of his strongest hold:

> Your committee believe that the attempt to exterminate the gypsy moth in eastern Massachusetts has been justified by the results already obtained, and its practicability demonstrated. They therefore plan to continue the work in 1899 on the same lines as in 1898. An appropriation of $200,000 is therefore recommended for the work of the ensuing year, this sum to be expended in no half-way measures of suppression, with the results of continuing the work indefinitely, but with the sole view of the extirpation of the gypsy moth from this Commonwealth.[3]

Impressive results would be needed to allay mounting fears in the General Court, but an uninspected belt of towns surrounding the infested area would need to be examined thoroughly. The committee said the state should expect at least ten more years of inspections and minor efforts to ensure that the moth had been truly eradicated. With regard to the sum of nearly a million dollars already expended to fight the gypsy moth, the committee quoted Howard's

dismissive remark that the amount was but "a drop in the bucket" compared with the potential losses from billions of unchecked larvae; Fernald likewise brushed off the expenditures as "a mere bagatelle" when viewed against the costs of protecting the entire state indefinitely.

The legislators did not think the money spent was inconsequential; to them the outflow of cash represented a financial hemorrhage that had to be staunched. The state was throwing good money after bad, and the vague predictions for the outcome of the effort left politicians suspicious that the campaign would become a perpetual money sink for the taxpayers. Moreover, the war against the gypsy moth had been overshadowed by a real war against Spain, and for the first time in years the governor's inaugural address made no mention of exterminating insects.[4]

Four hundred men were retained to destroy egg masses in the woodlands during January. The committee met on January 18 to reconstitute itself after the death of S. S. Stetson, following which the members voted to suspend all effort within a few weeks. Kirkland wrote, "It hardly seems probable that we shall work the entire month through."[5] Efforts ceased on February 1, and the entire force was dismissed after the legislature failed to vote an appropriation. An emergency allocation of $30,000 dollars became available in mid-February, passing after contentious legislative debate and squeaking through by just a few votes. Work did not resume for a week due to heavy snow accumulations. The bulk of the appropriation was used to pay for the expenses of January, and the remainder lasted until March 9, at which time about three hundred field workers were dismissed.

Meanwhile the yearly hearings and debates on the gypsy moth appropriation had been taking place, and it was common knowledge that the appropriation bill did not have enough votes to pass. Testimony given in 1900 by Senator Ross and others left little doubt that the lobbying effort on behalf of the gypsy moth bill had been intense: "We were hounded almost to death, almost to desperation, [employees of the gypsy moth department] were piling in, and they would come to this man and say to him: if you will vote for this man and so and so, he will vote for your bill. . . . [I]t was common knowledge that many bills were tied up, held back, until certain people were seen."[6] Legislators were promised the opportunity to obtain jobs on the field force for unemployed men in their districts if they voted for the measure. Senator Ross identified Kirkland as one of those who had lobbied him on several occasions about supporting the gypsy moth bill and who had informed him that he might as well vote for the bill and get his share of men employed.

At the same time, legislators who were trying to pass an appropriation to renovate Carney Hospital in Boston similarly did not have enough votes because of prejudice against Carney, which was a Catholic hospital. In a great

example of logrolling, supporters of the gypsy moth appropriation and those in support of Carney Hospital voted for each other's bill. On April 15 the gypsy moth appropriation of $170,000 passed by a small margin, much to the ire of opponents who had once again been outmaneuvered by the surprising political skill of the gypsy moth leadership. The editors of the *American Naturalist* were dismayed by the sums of money given to the Board of Agriculture in the last two years and wrote: "Is it not sometimes the part of wisdom in a prudent business man to let a bad investment go, rather than to lose more money by trying to save what is already lost?"[7] Senator Ross, who voted in favor of the appropriation in 1898 and against it in 1899, recalled: "A member of the House said to me that he would sooner cut off his right hand than vote for the Carney Hospital appropriation, and yet, when the vote was taken, he voted for it, and I asked him why. He says, 'God knows I had to do it to save the gypsy moth appropriation,' and so the methods that were adopted to get this measure through . . . so completely disgusted me that I was forced to think I had done something wrong in my vote the year before."[8]

As soon as the money became available, the force was reassembled and sent into the field. The problems of almost every preceding year were repeated: skilled employees had been lost; new hires could not be used until they had received training; and the lack of experienced workers made each step longer and costlier. Forbush decided that the main effort of the year would be made with burlap because of the need to work in wooded parklands, where the commissioners were very restrictive about allowing fire. By the end of spring his force of 570 men had banded 2,500,000 trees, an undertaking that consumed fifty-three tons of burlap cloth and uncounted miles of twine. To this astonishing number was added one million still useful bands from the previous year. Forbush wrote: "The work of burlapping was pushed with utmost diligence. All other work was given up, and wherever caterpillars were found the burlaps were examined as often as appeared necessary. In those localities where the greater number of larvae were found the bands were visited once a day and even oftener in extreme cases. As a result of this work the larvae were killed off so rapidly that few matured."[9] In addition, the spring of 1899 was a dry one favorable to both caterpillars and spraying. Kirkland reported that the weather made the application of lead arsenate especially effective. Forbush too said that the weather was ideal and that wherever trees were sprayed, the caterpillars were almost entirely destroyed.

Although the moths were present in greater or lesser concentrations throughout the infested district, the worst spots were in Georgetown, Newton, and the Middlesex Fells. The severest infestation occurred in July in the Long Hill colony at Georgetown, which, along with the colonies in Newton and

Manchester, were new infestations that had been discovered during the winter—and all the new ones found this year were outside the boundary of 1891. The colony at Georgetown was particularly distressing to the committee and the field director because it was only eight miles from the New Hampshire border. People living in the Newton region had reported infestations every year since 1897. The street commissioner of Newton testified at the hearings of 1900 that he had discovered the colonies in 1895 and given notice, but nothing had been done. The scouts Forbush sent in 1897 and 1898 reported that they did not see any signs of the gypsy moth. There is no telling why the inspectors could not find any, but by 1899 the colonies were large and well established.

Once again, the committee found it had spoken too soon about the scarcity of egg clusters throughout the region. The spring hatch of caterpillars swarmed in enormous numbers for a third consecutive year, and several acres of trees were defoliated. Although the devastated area was small by modern standards, so many denuded trees in one place presented an alarming sight. Citizens reported that the speed of the caterpillars as they swarmed from defoliated areas was like a fire spreading outward across a dry forest floor.

In Georgetown, thousands of caterpillars crawled over every tree, reminding Kirkland of "the almost incredible tales told of the now historic moth outbreak of a decade ago in Medford."[10] Twenty men with cyclone burners battled the hungry larvae for days. For the first time an attempt was made to confine the insects by cutting an isolating path around the infested area. Stupendous quantities of caterpillars were destroyed, but they could not be killed fast enough, and astonishing numbers of them survived to pupate. As female moths appeared and began to lay their eggs, Forbush called for drastic action as Kirkland described: "Fire and axe were applied. . . . Trees were felled and thrown with their festoons of pupae and clusters of eggs into bonfires; the flame of the cyclone burner was applied to ground, ledges and walls, and all remains of the moth were done away with."[11]

The Newton colony was intractable, and thirty men were sent there to band the trees. It should not have surprised anyone that the more the insects were fought, the wider became the area in which they were found. The tract occupied by this single and supposedly small concentration ultimately was found to encompass four square miles, compelling Forbush to keep his men in Newton for a month setting pastureland afire, felling trees, and putting an old building to the torch. Fletcher Osgood, a participant in the wild struggle, wrote a melodramatic review of his comrades in combat: "Such is the life of the gypsy moth worker—combating the pest with axe and brush hook, chemicals and flame, with knife, spatula and crushing palm, in all weathers and in

all seasons, called it may be to make of his working ground a veritable slaughter pen, wherein the devastating pests are flung by brimming bushels into trenches, like the dead in battle."[12]

The leadership of the campaign took the position that the work through the end of 1897 had been only suppressive in nature because of meager funding. Having stated a number of times that they required $200,000 annually to exterminate the moth, and having at last received it for two years in a row, their need for success now became absolute. The moths could not be allowed to gain more ground. Forbush threw all the force he could muster into the battle, and pushed his men past the limits of their endurance.

J. S. Pray, who worked for the Olmsted Brothers, had visited the infested parts of Georgetown and Newton before any work was done and recalled being impressed with the "immense, sickening masses of larvae and pupae upon the old trees there and upon the old shanties within the infested district."[13] He said of the workers: "They were as hard worked men during the season as can be. They were working much harder than they had any right to from their own personal point of view, and many of them, as you know, knocked themselves out physically by the intense strain, . . . the hard, physical strain of it day after day."[14] Sometimes the men became so fatigued they could hardly stand on their feet, yet as C. W. Brown testified, if they fell out for even fifteen minutes toward the end of a grueling stint, they were docked an hours' pay: "It was not customary to loaf at all. . . . I says [to Inspector Holbrook], 'we will go in and rest, I am tired.' And I says, 'you can put it on to the bottom of your report, and if they wish, they can dock us for the time, as I am completely exhausted.' . . . I have worked for a good many different people, a good many bosses, [in] a good many different parts of the country, but I never in my life worked for a Commission that extracted so much from their men."[15]

So many caterpillars survived to pupate that the committee decided to destroy pupae by burning brush and scrub woods in July and August, despite dangerously dry conditions. As leaders had feared, the moths were now making annual forays from their woodland strongholds into areas previously cleared of their kind. The patient citizens of Medford demanded an explanation; Walter Wright could not understand why the committee clung to the idea of eradication when all evidence seemed to the contrary: "Here [in Medford], nine years later, within half a mile of the origin [of the gypsy moth in America], in a mere village neighborhood, on level grounds, no wood lands, simply apple trees in good preservation, the moth was not exterminated, so that over 50 were taken from one tree at the first search last summer. . . . I should not dare to estimate the number taken under burlaps in Medford last year at less than two million."[16]

Arlington was also heavily infested, but to show that the state was gaining the upper hand, some inspectors began to present inaccurate numbers. General Agent J. A. Farley, a high-ranking member of the director's office, observed as one special inspector and a crew of two men worked through a dense colony on Oakland Avenue one Friday morning. After watching for some time, Farley asked the special inspector for his estimate of egg clusters and was told there were about two hundred. After finishing work, the special inspector reported to his superintendent that only twenty-three egg clusters remained. Incredulous, Farley returned to Oakland Avenue the next day: "My estimation of the nests in that colony, according to my experience, was that there was 6,000 nests. The leaves were literally plastered with nests, so that you could work on a space of a square foot for an hour, treating nests, and then turn [the leaves] over and spend another hour. There were over two acres infested in that way."[17]

Fernald and Forbush were hard put to understand why so many larvae were hatching each spring and remained baffled by the mechanisms of gypsy moth population dynamics. They theorized that population outbreaks were related to favorable weather conditions that allowed insects to pupate faster than predators could depress their numbers, but they refused to consider the possibility of inaccurate reports. They directed the scientific corps to collect more egg clusters and count the individual eggs. The average obtained was not the 450 to 500 eggs per cluster that Forbush and Fernald had been using for most of their campaign calculations but a little over 600 per cluster.

Since much of the work in the last days of the war was being done in the Middlesex Fells, the clusters counted were probably taken from there. The greater number of eggs per cluster indicates that the moths were living under highly favorable conditions and their colonies were robust. In 1895, Forbush had claimed 90 percent destruction but wrote in 1896 that he did not understand what caused massive outbreaks.[18] In the annual report for 1897 he cited 95 percent destruction of the moth in all its forms, showing that he still employed very nearly the same methods and continued to estimate about a six-and-one-half times annual increase of the moth per year.[19]

Much of the effort was concentrated in the woodlands where the insect in all its forms was destroyed by hand. The committee reported that the beautiful Lynn Woods area was thoroughly infested and the magnificent Fells in even worse condition. The committee used what it termed "heroic" efforts in the woodlands outside the reservations, which consisted of burning all brush and cutting all trees labeled as "worthless." The strategy was to drive surviving gypsy larvae to the few remaining large trees, where they could be captured under the burlap bands and killed. This effort became extreme during the last two years of the campaign as the field forces engaged billions of moths in

forested areas that could not be sprayed. Private woodlands were logged extensively and, some felt, excessively in the compulsive effort to deny the larvae their food. I. J. Colbert, who worked on a chopper gang during the last few years of the campaign, recounted his experiences on land belonging to a Mr. Cox in Winchester:

> We cut in the neighborhood of 2700 cords of wood. We went through that piece of wood land, which was an unusually fine, straight growth of wood, we went through that wood and cut everything about clean, probably left one tree every 50 or 60 feet. . . . The wood was split and piled, logs were sawed and saved, and everything was done in ship shape. The ground was cleaned up, the brush burnt, wood piled in cords so that it could be easily measured, and everything was done except selling the wood and cutting it up for fire wood. If we had a little more time we probably would have done that.[20]

The park commissioners had other ideas. They would not allow even the youngest saplings to be destroyed, which forced the gypsy moth warriors in some cases to clear infestations by crawling on their hands and knees to overturn rocks and inspect the trunks and lowest branches of the smallest trees. Tall trees had to be cleared of egg masses one at a time by light and agile men called "squirrels," who donned metal climbing irons to ascend the trees without ladders. After the female moths had laid their eggs, the workers undertook the astounding task of removing more than three million burlap bands from tree trunks distributed throughout a region of more than 220 square miles, clearing off or creosoting all the egg masses found underneath, and then tying all the burlaps back on again.

Brown-tail Breakout

Roland Thaxter, with his son Charles Elliot and family, departed Cambridge in June for their summer place on Cutts Island, Kittery Point, Maine. The brown-tail moths were making life miserable for everyone each summer, and the thought of cool Maine nights and pure, refreshing ocean breezes without any brown-tail hairs in it was very appealing. In 1897, Roland Thaxter had been among the first to notify the gypsy moth committee about the new caterpillar defoliating his pear trees, and his house was at the center of Cambridge's brown-tail infestation. There were many kinds of moths flapping about the Maine island at night as well, but this time the Thaxters came across some that looked too familiar. They netted a couple and realized the insects were brown-tail moths. On July 14, 1899, young Charles wrote to the Maine

State entomologist, F. L. Harvey: "We have caught two brown tail moths this month, one on the wing July 3d and another at rest July 12. My father thinks the cocoons or caterpillars must have been brought here from Cambridge two summers ago on our household goods, as brown tail moths were plentiful about our house in Cambridge while we were packing. My father feels sure that they were not brought this year and thinks that they are likely to have become established on this island."[21]

Harvey wrote to the Thaxters asking for samples, which they sent. The insect was identified as a brown-tail, making the spread of imported moths a problem that now affected three states. Exterminating the brown-tail in Massachusetts at once became a pointless effort when Harvey announced that the moths were on the Maine border with New Hampshire.[22] Nevertheless, a feeling was starting to come over the field superintendent and others that this insect was not going to become the feared second wave of incessant defoliation. The initial surge of expansion had been a fluke, for the brown-tail was not as rugged as the gypsy moth, and it attacked a far narrower range of hosts. Clipping winter webs and burning them guaranteed that an area would be free of brown-tails the following summer. The night-flying moths were taken in great numbers by bats. The moths flew into arc lights and electrocuted themselves at the rate of more than a hundred per fixture each night. Each lamppost became a moth dispensary for predatory birds. English sparrows made daily visits to the lamps and captured the moths easily. Waiting toads devoured injured moths that fluttered to the ground.

Fernald and Forbush, anxious to get an idea of how potent a suppressing force was exerted on the brown-tail moth by birds and bats, assigned the task of enumerating the brown-tail's losses to Kirkland, who soon found himself in a quandary. If he canvassed the arc lights late in the afternoon, birds would have eaten most of the moths. If he tried again at dawn, the bats would have finished their work, leaving nothing but piles of moth wings on the ground under the globes. The most Kirkland could do was count wings and divide by four. But he also discovered an unsuspected and surprising ally: "Whatever may be the sins of the English sparrow, we must give them credit for destroying large numbers of brown-tail moths. Not only do these birds eat the moths themselves, but they also feed them to their young. I saw the sparrows repeatedly hunting along fences and carrying off the resting moths to their nests in July of the present year. At Somerville last year it was no uncommon sight to see flocks of twenty or more sparrows collecting the moths from a picket fence."[23]

By the middle of summer the gypsy moth campaign was entering its twilight months, placing its leadership in awkward personal and professional positions. Forbush's health was becoming a concern to him, although he did not

generally advertise it to others. He insisted publicly that the forces of Massachusetts were doing the best and most effective work they had ever done, but privately he cautioned chemist F. J. Smith that after this year there probably would be no more work for him. Smith wrote to Fernald on June 13, 1899, to see if this were true and to ask Fernald's help in finding a new job.[24]

Interest in control by parasites continued to wane. C. Kochi, a Japanese student of Fernald's at Amherst who was doing graduate work at Cornell under Comstock and Gage, sent a hymenopterous parasite to Fernald on July 15 with the promise to send another one soon.[25] As with the Japanese parasites sent in earlier years by Loomis and Riley, however, there seems to be no record that Kochi's specimen arrived alive or that any further work was done with it.

Laissez-Faire

During the middle of August, Forbush and Kirkland took a break from the constant demands of their work in Massachusetts and traveled to Columbus, Ohio, with Fernald to attend the eleventh annual meeting of the Association of Economic Entomologists. Kirkland, who was the association's secretary this year, presented a paper on lead arsenate, and Forbush read two papers, one on birds that attacked hairy caterpillars and another on the gypsy moth work in Massachusetts; in the latter he confidently announced to the audience that "Porthetria dispar will be a rare insect in the infested region in the year 1900."[26]

Perhaps the most astonishing moment came during the opening address by President Charles Lester Marlatt, an expert on the San Jose scale. Although he confined his talk to this particular insect, his words were aimed at all insects that entomologists had declared as pests and were attempting to eradicate:

> Has an important insect pest ever been exterminated? Does not the locust still flourish, and is not the cankerworm still a burden? Are not all the insect plagues of our forefathers to the remotest times still with us? . . . [A]re we not merely repeating and putting into effect the boast of the courtiers of King Canute that at his command the tide would roll back; and are we not, like that good old king, though unwittingly, giving a practical demonstration of our own impotence by having the tide of failure roll up around our bodies?[27]

Marlatt went on to propose a laissez-faire approach to what he called the normal progression of nature; he counseled that only small, localized exterminations should be attempted when conditions were dire because it was obvious to him that nature was capable of taking care of herself. Not a person

in the room, he continued, had ever been deprived of the necessities of life because of an insect. Marlatt recalled growing up in the midwestern corn and wheat belt during the worst days of the chinch bug, the Colorado potato beetle, and the Hessian fly, and pointed out that not a farm in his memory had ever been abandoned solely because of insects. It was undesirable to cry out in alarm every time a new insect pest was discovered, he said, and hasty failures at extermination only served to make economic entomologists look foolish.

The effect of Marlatt's speech was to throw the small assembly of economic entomologists into turmoil. Just nine months before, Fernald had released an updated danger bulletin in which he stated unequivocally that the gypsy moth was the greatest insect peril in the country.[28] The document dwelled on such inflammatory points as the insect's ravages in Europe, the extreme devastation of forest trees, the loss of domestic crops, the vastness of regions overrun, and the numbers of people driven from their homes by an insect that was claimed to be far more destructive in North America than it was anywhere else. Marlatt's condemnations went right to the heart of that document, and Forbush responded that exterminating insects had both an optimistic and a pessimistic side. He made the astonishing argument that when a foreign insect was weak (as the gypsy moth was, he thought, because the female could not fly), it was vulnerable, and therefore extermination was a good course—somehow forgetting that after almost ten years of effort and expenditures approaching a million dollars, the Commonwealth had been able neither to eradicate the moth nor to hold it in bounds. He contended that had a laissez-faire policy been followed, "many States would now be suffering from the pest."[29] The discussion that followed was lengthy and intense. Most of those in attendance did not believe Marlatt's observations: some argued against them; others simply rejected them outright. Forbush claimed later that every entomologist at the meeting had opposed Marlatt's conclusions.[30]

Reconsideration

Fletcher Osgood had resigned from state employment and entered private industry in May 1899; he remained interested in the campaign, however, because he was working on an article about the gypsy moth war for publication the following year. Osgood wrote to a state representative, Crosby of Middlesex, and asked to interview him. Crosby had been on vacation in Maine, but upon his return in early September he invited Osgood to visit and learned that Osgood had concluded extermination could not succeed: "In the course of his remarks Mr. Osgood told me that Mr. Forbush himself had told him after the passage of [the gypsy moth bill] that this work was merely a question of patronage. Mr. Forbush has denied it. . . . And Mr. Osgood says to me, 'I

will give Mr. Forbush the credit of sighing when he said it.' . . . I believe in a burst of frankness, in a burst of disgust, if you please, the field director spoke the truth and spoke his true sentiments at that time."[31] Osgood also mentioned that eggs treated in the lab with the same creosote oil that had been used for years were now hatching. When Crosby asked him what that meant, Osgood replied, "You can draw your own inferences."[32]

As the leaves fell from the trees, the remaining members of the field force turned their attention to a halfhearted assault on the brown-tail moth, a task that occupied them for the rest of the season. Workers used pruning shears on long poles to reach into the canopy and snip nests off the branches; then the fallen vegetation and its slumbering insect inhabitants were raked into piles and burned. The workers were unenthusiastic about combatting the brown-tail, and Osgood noted a similar lethargy on the part of the public: "I have seen little orchards of short pear trees loaded with brown-tail webs, as if they bore a heavy crop of withered fruit, which the occupants or owners, at no expense to speak of, could readily have cleared, but which they chose to neglect. . . . Such incidents are typical of a prevailing mood. Allowing for many exceptions, we must, I think, admit that the average owner or occupant of an estate is indisposed to clear it of the brown-tail, even though the law requires that he shall."[33]

Forbush prepared his annual report, complaining as usual that he did not have enough men to prosecute the work, and that he could not find enough men to hire. He also stated again that work in the field would have gone better if he had been given more money in a timely fashion. But in the last two years of the campaign, that argument had lost much of its force: the Board of Agriculture received the full amount it had requested for two years running, and emergency appropriations had been made available to tide the fieldwork over until the full appropriation came to a vote.

In fact, the actual number of men at work against the moth was always larger than Forbush claimed. Little notice was given to the gypsy moth gangs created by infested communities such as Medford, Malden, Newton, and others—municipalities left in the lurch so many times that they had formed their own crews, and some even bought their own spraying apparatus. It is no longer possible to know how many additional men were at work on their own or employed by agencies outside the Board of Agriculture, but in the central cities gangs of fifty men or more were reported, indicating that manpower was not a severe problem.

Samuel Crocker Lawrence, Medford's wealthiest citizen, attended to his four-hundred-acre estate, Seven Hills, located in the heart of the city. Lawrence kept his magnificent parklands open to the public and owned modern sprayers that he used to battle the gypsy moths from the beginning.

Lawrence's men helped citizens who could not afford to take care of their properties themselves, and toward the end of the campaign he often employed more than one hundred workers at a time. Some estimates are that he spent a half-million dollars of his own money on gypsy moth work before the campaign was over.[34] General Lawrence did not reveal the amount he spent fighting insects except to say it was more than he cared to mention. His forces alone boosted the number of men by 25 percent. Municipal gangs raised that figure even higher. Other citizens such as Albert S. Sise, Walter Wright, and the Frost brothers were doing much the same work as Lawrence, although on a smaller scale. Perhaps thousands of individual landowners large and small throughout the infested region were also going after the moths or hiring professional exterminators to do the work.

Since Lawrence's support was critical to the success of the effort, his crews were trained by the state early in the war. Late in the campaign, many citizens felt that Lawrence's crews were more efficient and got better results than the state's forces. Courteous and helpful, they were welcomed wherever they went. State crews needed to press for the maximum amount of work in the shortest possible time, and not being members of the communities in which they worked made them largely indifferent to the citizens. Many residents became restive about the constant intrusion by state employees on their properties, and writers such as Eugene Wambaugh were concerned that the intrusions were becoming excessive.[35]

In October the remaining members of the state's army fell upon the gypsy egg clusters in Georgetown and Newton. Scouts went through the region noting areas that needed attention, followed by chopper gangs that "cleared up" the land and made the remaining trees ready for burlapping. The choppers had a busy year, felling nearly 469,000 trees and trimming almost 100,000 more.

Forbush always allowed for a certain number of bad-weather days when idle men could not draw pay. Stretches of good weather tended to use up his budget faster. When gypsy moth money ran out late in the season, the men would work under the small brown-tail appropriation until it was exhausted. The appropriations for 1899 were expended by the end of November, causing a cessation of the work and the release of all workers except field superintendents and their assistants, who remained employed until the end of December.

Despite the rising numbers of insects killed and the discovery of new colonies in Newton and Georgetown, Fernald, Forbush and the committee became almost delusional about the ultimate effects of their work and publicly stated that extermination was approaching. The committee reported at the end of 1899 that all the large moth colonies had been wiped out and that the remains of the smaller colonies would be gone within a few more years: "It is

unnecessary at this time for the committee to reaffirm its belief that the entire extermination of the moth is a possibility. The results of the past two years' work are sufficient to dispel any doubt on this point, and to make it plain to the most skeptical that if sufficient funds can be provided for a few years longer the accomplishment of the desired end will be an assured fact."[36] The committee also held that after a decade of combat the infestation was still confined within the boundary of 1891. Although the boundary had been enlarged to encompass about 225 square miles, colonies found outside the original limits were considered temporary and thus listed as exterminated within a year or two. In fact, the actual area of infestation had grown to 359 square miles[37]—information commonly known within the circle of economic entomologists in New England and by Leland Howard in Washington but apparently not to the public at large or the General Court of Massachusetts.

The committee, the field director, and the advising entomologist proudly pointed out that in many areas where infestations previously had been severe, one would be hard pressed to find even a single caterpillar during larva season. Moths populating the woods and parklands were now so strongly entrenched, however, that nothing within reason could be done to drive them out, and each spring the larvae would swarm from these places by the hundreds of millions. Later, when gypsy moth colonies in other states were thought to be undergoing extermination, the number of insects killed annually dropped dramatically until larvae, egg masses, and pupae were nearly impossible to find, yet in the Massachusetts campaign the number of insects killed each year rose markedly. Fernald dismissed the increased counts as proof that the state was gaining on the caterpillars. Former committee member John G. Avery too was sanguine about the appearance of massive new colonies: with the committee's experience and the materials available, he asserted, colonies of any size could be exterminated in the first year.[38]

When Forbush took the position as superintendent of fieldwork he had no idea what demands the job would impose on him. The gypsy moth campaign became all-encompassing, but Forbush considered himself equal to the task both mentally and physically. Although he was not an imposing specimen, he took great pride in his mental toughness and physical stamina. He liked to tell how he had cured himself of rheumatic fever after being caught in the open during a three-day rainstorm, a treatment that he later delighted in calling the "water cure."[39] Throughout his life, he had relied on himself at times when his life was at stake, no help was at hand, and failure was not an option. Yet even an individual who enjoyed the robust health that Forbush claimed could not continue such stressful work indefinitely without ill effects. Problems with his health showed up as early as 1897, when Howard observed that he was dragging himself through each day when he should have been in a sickbed.

During 1898, Forbush's health continued to be a source of concern, and during the effort for 1899 he was unable to work for many months, during which other factors too began to influence his position as field director.

Forbush took risks when he felt risks needed to be taken, even to going it alone when his instincts told him he must. He ran the campaign the way he ran his life, pushing himself and his troops as hard as he dared. Most of the men hated the pressure but stayed on because they could not make better money "on the outside."[40] The workers also resented Forbush's practice of "spotting," which subjected them to observation by men hired to see whether they were really working. Spying had been going on since 1892. Nathaniel Shaler had spied personally during his tenure and sometimes hired men at his own expense to spot for him. The workers thought it was crazy to have the director, an eight-dollar-a-day man, and his superintendents "spotting with fast horses."[41]

Forbush finally reached his limits of physical endurance and patience with the General Court; sometime during the second half of the year, he tendered his resignation. The committee, as once before, refused to accept it, instead granting him a three-month leave of absence and afterward stating that the reason for his resignation was poor health. Fernald wrote to to Leland Howard: "I suppose you have heard that Forbush has been given a leave of absence for three months and Kirkland has been put in his place. How did you find the work down there [in the infested region] and how were you impressed with it? Please write me about this matter as you feel and indicate what you are willing for me to make use of in my report."[42] The issue of health may have been a smokescreen, since John May mentions nothing about health problems at this time in his biographical sketch of Forbush but attributes the resignation to diminished appropriations. Forbush was well enough in early 1900 to ready personally his newly purchased retreat at Wareham, Buzzard's Bay, where he immediately began work on his book *Two Years with the Birds on a Farm*.

As acting superintendent, Kirkland wrote the annual report presented to the state by the board at its meeting in January 1900. Kirkland was remembered as a young man who had graduated from college six years before and experienced personal difficulties that tarnished his image. Since then he had pulled himself together, become a good entomologist, married a fine and interesting young woman, and become a Methodist. He slipped into the director's role with ease and displayed great maturity in dealing with a crisis situation. Fernald wrote: "He was my assistant . . . on the gypsy moth work, the last three months Acting Director where he showed himself to be such a man of affairs as to surprise [me] and the Gypsy Moth Committee. He is a man of presence, a good public speaker, and what the western people call

a hustler, one who will work incessantly."[43] Kirkland declared that the end of the gypsy moth was in sight, and the committee considered this statement "indisputable."[44]

On December 8, 1899, a special meeting of the Board of Agriculture was held in the Town Hotel at Amherst. The board wanted to review its powers and positions and hear the comments of Charles Fernald, who also was present. The two-dozen board members in attendance voted to accept Kirkland's report, with thanks to Fernald and Forbush for all their hard work. Board members, as exemplified by Charles E. Parker of Holden, held out hope that a federal appropriation might be made in time to bail out what was starting to feel like a sinking ship. A motion was made that the governor request the state legislature to "memorialize" the United States Congress for help in exterminating the gypsy moth, and after the motion was voted on and passed, the meeting adjourned.[45]

[CHAPTER 16]

The Last Hurrah (1900)

THE COMMITTEE BEGAN the last year of the nineteenth century operating through January without an appropriation. The board formed committees that formed subcommittees to make one last effort for a federal appropriation, but in the end the matter was referred back to the gypsy moth committee for some unknown heroic solution; E. W. Wood, Francis Appleton, and William Sessions were delegated to draft such resolutions.[1] But events were moving too fast to be changed.

Scouts spent a great deal of time inspecting Boston and its wards of Roxbury and Dorchester. When Roxbury had been scouted in 1897, only one caterpillar had been reported; when it was scouted again in 1899, only three caterpillars were discovered, which led the committee to declare the ward practically free of gypsy moths. Then, in January of 1900, a huge colony was found on West Cottage Street, an infestation so well established and severe that 1,600 egg nests were taken from a single elm tree.[2] Moths were found everywhere except Franklin Park, which the committee pronounced cleared. The picture emerging from 1899 was not good. Despite a year in which the largest field force had operated under the most generous appropriation, the moth had made gains. Everett, Malden, Medford, and Melrose were listed as infested, and all the other inspected towns contained egg masses except Georgetown, where only a single cluster was reported.

Medford was in the worst condition, with egg clusters visible in almost every part of the woods. Although such individuals as Samuel C. Lawrence and Albert S. Sise had expended considerable sums in private engagements with the moths and achieved acceptable results, others had not fared as well. Walter Wright's estate remained infested even though he fought moths all season long with hired help; his employee reported destroying "twenty-eight thousand larvae in a space of thirty square feet."[3] A large percentage of homeowners had given up the fight as unwinnable, leaving the moth with multiple retreats from which it could reinfest the lands of those who had worked to clear their premises.

The committee on gypsy moths, insects, and birds finally got what it had been asking for—an independent panel to investigate the work and report to the General Court. But it soon became clear that the panel's members were no friends of the gypsy moth committee, the Board of Agriculture, or the policy of extermination. On January 16, 1900, a special joint investigating committee of the Massachusetts house and senate was created to determine the question of extermination and report its findings by February 15. Because the Senate did not concur until January 22, the deadline for the report was extended until March 22. The house members of the committee were Charles F. A. Smith of Waltham, James F. Bliss of Boston, Edwin J. Mills of Fall River, Charles A. Carruth of Athol, Charles O'M. Edson of West Brookfield, Temple A. Winsloe of Boston, Frederick O. MacCartney of Rockland, and John L. Donovan of Boston; members from the senate included Loyed E. Chamberlain, Thomas W. Kenefick, and C. W. Hazelton.

On January 26 the investigators hired stenographer Arthur T. Lovell and got to work. They held seventeen public hearings, beginning on January 30 and concluding on February 26, and called 125 individuals to testify (members interviewed citizens who could not attend). Witnesses included present and former senators and representatives, members of the Board of Agriculture, entomologists, town officials, market gardeners, farmers, citizens, and a large number of present and former gypsy moth workers.[4] On three of the days that no hearings were scheduled, committee members visited the infested regions, although in February there was little to see. The format was the same as it had been for all previous hearings with the Board of Agriculture allowed to present its witnesses first, followed by the opposition, and concluding with a rebuttal period during which all witnesses could correct errors or clarify ambiguities.

The annual reports of the gypsy moth committee and the monograph of 1896 were closely scrutinized by Alfred E. Barker, the former senator, who believed his stand against appropriations several years earlier had turned the moth men against him and was responsible for his defeat at the polls. He testified that the moth committee had long misrepresented its progress:

> Their reports here show that they have never given the Commonwealth the true state of affairs, or else they have made those reports for the purpose of getting from this Commonwealth their annual appropriation, and getting it bigger every time. . . . There is only one thing consistent in their reports from beginning to end, and that is: More money, and more money, and give it to us quick; that is all. . . . There is not a point of failure which they point to here; there is not a place where they have made a promise that has not been fulfilled where they have not come back and laid it on the Legislature.[5]

Charles Fernald was among the first to testify and did his best to protect others involved in the work, saying that he was personally responsible for any errors or mistakes and that any missteps by the board occurred because they were "following the advice which I have given them as closely as they could."[6] Fernald received a polite hearing from the investigators, but his disputations had been heard before and were now considered fantasies. No longer able to present any compelling arguments and sensitive to comments made about him by others, he had trouble focusing, sometimes contradicted himself, occasionally asked the investigators to repeat their questions, and digressed into anecdotes about the campaign. At a couple of points, the chairman interrupted Fernald to ask him the purpose of relating these reminiscences. Fernald's luster had dimmed, and Senator Leonard Ross testified that he had endured entomology in general and Fernald in particular longer than he cared to: "I have known of Prof. Fernald, the entomologist in this work,—and I care not whether he is present,—I believe him to be an enthusiastic, capable and efficient entomologist; I believe he is worth more as an entomologist because he is prejudiced . . . I believe that Prof. Fernald would believe that he was doing his duty honestly if he were to see every dollar in the treasury of the Commonwealth spent to exterminate bugs."[7]

The investigators were keen to know why work with parasites had been blocked so often, and again Fernald tried to shoulder the blame. He had never been able to take the decisive step of recommending a legislative petition amending the enabling act so that such explorations could begin. At one point during questioning the following exchange occurred:

> CHAIR: Now you say there has been no effort made by the Legislature to send experts across the water; you say here nobody has ever asked it. That is true, is it not?
> FERNALD: . . . I am very sure the Legislature has not been asked.
> CHAIR: You asked the Attorney General if it was possible under the present appropriation to do such work, and you found you could not?
> FERNALD: We could not do it without a direct act of the Legislature.
> CHAIR: Did you ever ask . . . for a direct act of the Legislature?
> FERNALD: I never have.
> CHAIR: Why has not the Board done it; is it not that important a matter?
> FERNALD: I think it is because I have advised them not to.[8]

Barker was incensed over the political incursions and manipulations of the gypsy moth committee and its field organization: "There is no man that knows

better his adversary than the man who meets him in battle, and when a man stands up and says he don't fight and he don't play politics, and I meet him in the arena and get whipped . . . I know he is in politics, and I know whether he is a good fighter or not. And I will say this, and I will say it without any personality at all, that these gentlemen not only know politics, but they are past masters in the art of legislative manipulation."[9]

The investigating committee worked swiftly and thoroughly because the matter was not new to them; many of the most expert men who testified had been advising the legislators since 1896, and others had testified in previous years before the ways and means or joint agricultural committees. In the eyes of the joint committee members, the views of a number of scientific men had "shed much new light on the scientific side of the work."[10]

Forbush returned from his recuperative leave in Florida in time to testify at the hearings and resume his position of field director.[11] Fernald and the gypsy moth committee viewed Forbush's return with relief. Fletcher Osgood was making a strong bid for the director's job and had gained support among civic leaders and legislators such as Wallace Spooner of the twenty-sixth district, Suffolk, who wrote letters to the legislature in Osgood's support.[12] Fernald was unhappy about the prospect of dealing with Osgood officially and wrote to Leland Howard that Osgood's maneuverings would cause them "a lot of trouble."[13]

As the hearings progressed, evidence began to accrue in favor of those opposed to gypsy moth work. In an effort to avert the inevitable, Fernald played his last card by once more soliciting letters from colleagues in other states. The results proved to be too little and too late, but one of the responses reveals how far the economic entomologists were prepared to go to influence public opinion. Ephraim Felt, Lintner's successor as state entomologist of New York, had conspired to have a letter in support of moth work published in the April edition of *Country Gentleman* magazine, commenting on the adverse recommendations of the investigating committee. Felt wrote to Fernald: "This letter is not signed, though written by me, as I thought it might have greater weight if it apparently came from the editors and not from one who could be supposed to be even indirectly interested in the work."[14]

The investigators said they were unable to substantiate claims of permanent injury caused by the gypsy moth and concluded that the reports of damage had been vastly exaggerated. They challenged the economic argument that had been the mainstay of the extermination campaign. The investigators claimed that the gypsy moth committee failed to show where any serious economic harm had been done by the insect over the preceding ten years and then dismissed the claim that the insect was a menace to agriculture:

> We find no substantial evidence that gardens, crops or woodlands have suffered serious or lasting injury, or are likely, with that proper precaution and oversight which prudent owners are predisposed to give their own interests, to be subjected to that devastation which one would have a right to anticipate from [the board's] reports. . . . It appears to us that the fears of the farmers throughout the State have been unnecessarily and unwarrantably aroused, evidently for the purpose of securing the effect of those fears upon the matter of annual appropriations.[15]

Put off by the committee's practice of advertising the insect in a way that frightened, rather than informed, the public, the investigators did not "share these exaggerated fears"; they said that "the prophesies of devastation and ruin are unwarranted, and in the most charitable view are but the fancies of honest enthusiasts."[16] The investigators noted that those awaiting the moth always expressed the greatest alarm, whereas the farmers and market gardeners who lived within the infested district remained confident they could handle the problem themselves. Representative Crosby of Middlesex testified: "I believe also that a large part of the pressure that comes in favor of this work . . . has been caused by apprehension, almost hysteric in some cases, caused by the discussion of this question and caused by much of the literature which has been put forth by this commission, not alone by this commission. In other words, I believe that the dread and apprehension from the gypsy moth does not come from the infested district. I know it certainly does not come from my district."[17]

Although the investigators conceded that the board had made "fair" and "reasonably accurate" reports over the years and had praise for Fernald's scientific work, the matter of expenditures had galled them for some time, and they let loose their full displeasure on Forbush and the gypsy moth committee. They were especially upset about the size and structure of the field force and the quality of supervision, and they were particularly displeased by the practice of scouting, which they called "hunting for work." Forbush's practice of retaining his most expensive employees between appropriations was faulted repeatedly, as was his practice of using these "officers" to perform the work of "privates" at no loss of salary. The investigators accumulated much evidence to show that often the ratio of ranked men to privates was 1 to 1, and during April 1899 there had been thirty-one clerks, stenographers, and other office personnel drawing pay while no fieldworkers were on the rolls at all.

Forbush was further rebuked for insisting on obsessive accountings of trees cut down, walls torn out, trees burlapped, acres burned, egg masses destroyed,

caterpillars crushed, and other minute statistics that required a large number of individuals and long hours to collect and compile. The investigators thought the results obtained were worthless and that the money spent would have been put to better use in the field. Endless inspections far from the infested regions were also singled out as undertakings that produced little of value but put a drain on the budget with such costs as equipping the men and paying boarding expenses for them and their horses.

The report noted that the committee's efforts to exterminate the moth were misdirected and that the organization of the work had resulted in an "unwise, unbusinesslike and extravagant expenditure of State funds, in part due to the principal [sic] under which the work is now carried on, and in part due to mismanagement." The investigators believed no private enterprise could sustain its operation burdened with so many mid- and upper-level employees and so little grasp of the fundamental problems, and they cited a mass of evidence "showing instances of misdirected efforts, inefficient management, incompetency, and entire failure properly and wisely to safeguard the State's interest."[18]

The investigators saved some of their best remarks for scouting as it was organized under Forbush, calling it barren of results and a waste of money. They noted the tendency of men in the scouting parties to hunt squirrels or take naps—so much evidence had been brought forward they had no choice but to believe it—and ridiculed those who stayed on the job as well:

> Dozens of men racing through the woods a hundred yards apart, with the avowed object of locating nests and noting evidence of the existence of insects, present a ludicrous and contemptible exhibition of inefficient management somewhere. Sixty scouts solemnly tramping through the streets of Boston last January, at an expense of over $125 per day to the State, looking for the last moth and an opportunity for spending more money in the coming summer, present an element of grim humor too pronounced to be resisted.[19]

The board was also chastised for laying waste great tracts of land to deprive the gypsy moths of food. In one instance, more than twenty-five hundred cords of wood were cut and sold from the lands of H. L. Cox, even though Cox, who lived there, testified that he had no knowledge of gypsy moths being present. The investigating committee pointed out that the state performed the work, the owners reaped a profit, and the employees received their pay, but all this had done nothing toward extermination. Devastating the land to fulfill what the investigators termed the "prophesies" of the board's entomological adviser showed only how desperate the board was to exterminate the gypsy moth.

The average private was a pick-and-shovel man who turned burlaps because it paid well, and it would be easy to believe that these men cared for nothing more than their paycheck. Yet some of them, such as Joseph F. Toole, were appalled at the radical work they were asked to do: "In 1896 there was 132,468 trees cut, in 1897 it is 279,101 trees, in 1898 they cut 376,468 trees, and in 1899 they cut 468,790 trees, making over a million trees they have cut since the commission started. Now I want to know how long it would take the gypsy moths to kill a million trees."[20] Inspector Ralph Hoffman said the work "made a terrible havoc in places that were beautiful, and at the same time [destroyed] the nesting places for numbers of birds which would keep down . . . insect pests."[21]

The skills acquired by the gypsy moth committee over the years in manipulating the appropriations process disgusted the legislators. The wheeling, dealing, logrolling, management of public opinion, advantage taken of inexperienced elected officials, question of patronage, and the political nature of Forbush's office had become matters of great concern. Many legislators had come to loathe the annual gypsy moth hearings, which they said were always announced by the presence of Director Forbush in the lobby, Professor Fernald in the witness chair, the board stenographer in the gallery, moth men packing the halls, and Mr. Kirkland behind every pillar and column.

Forbush was accused of using his office to help citizens circulate petitions supporting moth work and in one case initiating such a petition personally. His practice of having his office stenographer in the gallery recording each legislator's remarks—"so that the Board might know what was said against them"[22]—drew a sharp rebuke for not maintaining a respectful distance between the administrative and legislative branches of the government:

> The evidence satisfies us that the activity of employees in interviewing local representatives in the Legislature is fostered and encouraged by high officials [of the board], and that public sentiment is developed and directed for no other purpose than to change the present honest and conscientious opposition. No doubt those having the matter in charge, in view of the opposition that has arisen each year to the appropriation, and the feeling of antagonism that has each year been plainly shown, and believing so thoroughly as they have in the necessity for continuing the work, have felt justified in allowing such things to be done.[23]

The investigative committee said the entire ten years of the gypsy moth campaign had been based on the prophesies of economic entomologists, but that the state could no longer follow such guidance absent assurances that

could not be given. The attempt to do something unprecedented in the natural world might have possessed some merit as a scientific experiment, but the time was over for trials intended to prove the pet theories of economic entomology at the expense of the state. The question no longer involved the possibility of extermination because, as the investigators put it, "extermination may be possible and yet not practicable."[24] The joint committee concluded that the war had been against nature, and nature, they said, "is quite capable of taking care of herself."[25]

The economic entomologists had taken the position that reliance on natural controls to the abandonment of work in all other areas was unwise, but the investigators wanted to know why the entomologists had insisted on working in all the other areas while abandoning practical work in natural controls:

> Climatic influences, diseases, the preying of the higher upon the lower forms of life, the untranslated but ever-working law of migration and distribution, have one and all sprung into operation. The land still yields her bounty, vegetation still blossoms and is fruitful, the foliage is still green and the temporary annoyances are almost forgotten. It may be true that, until the insect or its parasite is thoroughly acclimated in a new country, the workings of these natural laws may be suspended; but the history of insect life shows that the law is never repealed.[26]

John B. Smith, the New Jersey entomologist who had long supported extermination in Massachusetts, provided the Commonwealth paid for it, was also criticized. Crosby discounted Smith's argument and the entire supposition of expertness on which it rested: "[Smith] says 'the moth may be,' he does not say that it can be. This is his opinion. It 'may be exterminated in America . . . provided money in sufficient amount be always available when needed.' I believe that any man who has been a member of the Legislature for more than one year knows that the Legislature will never, no matter how much they endorse this work, place sufficient funds in the hands of this Commission so it will always be available."[27] Crosby added that the work was not appealing to anyone with common sense, although inexperienced legislators often were persuaded to vote for appropriations after enduring poorly reasoned arguments for months on end. He said that assertions by those believed to be scientific men received a lot more weight than they deserved, that they were "inconclusive statements that scientific men make, which are taken for really more than they are worth."[28]

Marlatt's laissez-faire speech had damaged the notion that economic entomologists did not disagree about extermination. James Fletcher, dominion

entomologist of Canada, wrote to express his regrets to Kirkland (his reference to "wealthy people" was a swipe at Marlatt, who was financially independent): "I am sorry to hear you are having trouble with your appropriation. I am afraid Marlatt's ridiculous nonsense with the swell French name will not help you much. Laissez-Faire may do with wealthy people who do not care whether they succeed or not."[29] Francis M. Webster also wrote to Kirkland expressing his dismay that opponents of the gypsy moth bill were using Marlatt's speech, but added, "I do not think that any of us are much surprised that such is the case."[30] Forbush tried to convince the investigators that Marlatt had not meant what he said, that his talk had been restricted to the scale insect, and that Marlatt had later expressed his admiration for the work being done in Massachusetts.

The hearings of the investigative committee revealed, in addition to Marlatt, the identities of scientific authorities who were against the gypsy moth program. These included William T. Sedgwick of the Massachusetts Institute of Technology, Samuel H. Scudder of Cambridge, John Sterling Kingsley of Tufts College, Samuel Henshaw of the Agassiz Museum, C. S. Minott of the Harvard Medical School, and P. H. Rolf of the South Carolina Agricultural Experiment Station. All these men were of the same mind on the subject of extermination. As Sedgwick said: "I do not pretend to be especially expert in this matter, but it does seem to me as a scientific man and a naturalist, perfectly clear that the trials already made have sufficiently demonstrated the improbability of extermination, and that it is unnecessary and would be improper to continue them longer. I believe, therefore, that experiments aimed at extermination should be abandoned, and that the gypsy moth problem should be attacked in some other way."[31] Minott added: "I am of the opinion that the undertaking of the State of Massachusetts to exterminate the gypsy moth is, from the very conditions of the undertaking, entirely independent of any zeal, capacity or resources of the commission, an undertaking which is necessary to fail. I see no other possible result before it."[32]

Scudder, Henshaw, and Kingsley had been opposed to gypsy moth extermination from the start. Scudder recognized the danger of the insect but thought that to extirpate the invader completely it would be necessary to continue work long after no gypsy moths could be found, and in his opinion "no legislature could be induced to give $200,000 year after year after actual excessive damage had ceased."[33] Henshaw added that extermination was the province of nature and observed that the results of the extermination effort had succeeded only in spreading the moth further. He said that to destroy the moth beyond any doubt would require that the entire infested zone be turned into an "absolute desert."[34] He thought that a small appropriation for some state work should be available, but that property owners should deal with the

problem individually, noting there was "no reason why people should harbor such a dangerous pest on their places any more than they should harbor rattlesnakes or gunpowder."[35] Kingsley had been even more outspoken and earned the derision of many economic entomologists such as Clarence Weed, who wrote in 1894: "I was sorry to see Kingsley's editorial in recent naturalist. These chaps that rely on parasites show such a woeful ignorance of the laws of the subject that I am preparing a general article to enlighten them."[36]

Dozens of men who were or had been employed by the board testified in support of those opposed to extermination. These men told the investigators most emphatically their belief, based on their years of experience working against the moth every day, that extermination was not possible and that it would be better to reduce the moth's numbers only in places where infestations were serious.

Blinded by the Light

At the annual meeting of the Association of Economic Entomologists in 1898, President Herbert Osborn had told the membership that differences among scientists should be handled quietly because open dissent retarded the advance of science and the acceptance of its work. Osborn feared that open dispute would prejudice the public, a group he thought was mostly uninformed, merited little respect, and was slow to "adopt the results of science and inclined to be suspicious of even well-established points."[37] Yet the sword of silence swung both ways, and it undercut the credibility of testimony from economic entomologists, for their unanimous stance in support of extermination had astounded the legislature and, perhaps even more than the actual lack of progress of the effort, caused elected officeholders to seek opposing views. The investigators found a deep reservoir of contrasting perspectives from men who, in their opinion, had more scientific credibility than the whole lot of economic entomologists put together.

The joint committee forced the gypsy moth program under the glare of scientific objectivity, something the moth committee had managed to avoid by allowing only economic entomologists to express opinions. The state's method first puzzled and later angered economic entomologists, many of whom considered that no true men of science would publicly oppose a colleague in another field, right or wrong. The committee and the board were incensed by the testimony of Scudder, Henshaw, and Rolf. They were not as angered by the testimony of former employees since they considered much of it to be spiteful, but the accusations of other entomologists were viewed not as a matter of differing opinions but as acts of betrayal. Fernald was outraged, and Henshaw's appearance especially irritated him, as he wrote to Howard:

> I have spent the last two weeks in Boston and leave here tomorrow to return and the end is not yet in sight. Henshaw appeared before the committee yesterday morning in opposition to continuation of the work and was introduced as Professor Henshaw of Harvard University, an expert on such matters. His opinion will be taken by the Committee in opposition to yours and mine—just think of it: There has been more lying before that investigating committee during the past week by opponents of the work than I ever heard in all my life before. I did at one time incline towards the Universalist doctrine, but I have now entirely abandoned it and feel that if there is not a hell, there ought to be.[38]

Fernald remained indignant about "Professor" Henshaw, although when Forbush was mistakenly addressed as "Professor," Fernald raised no objection. He later wrote to Baron von Osten-Sacken that Scudder and Henshaw "never even took the time to look into the matter [and] fetched their conclusions from such thoughts as occurred to them in their libraries."[39] Fernald even became suspicious of Leland Howard, a man who sometimes acted more like a politician than a brother entomologist. Since Howard made several comments over the years that showed how quickly he could leap from one side of the issue to the other, Fernald wrote to him for promises that there would be no surprises during the hearings.

As the hearings wore on, Kirkland, Fernald, and Forbush endured many charges and accusations, and they all became edgy and short-tempered. Kirkland often referred to his opponents' tendency to use sarcasm as a tool that would cost them their cause, yet he fell into the same trap himself, mocking witnesses who did not base their opinions on the words of economic entomologists: "I should almost think of bringing in Mother Goose's Nursery Book as an authority on matters of entomology. They say a man is known by the company he keeps, and perhaps a man is known by the authorities he cites."[40] A frustrated Fernald complained that the investigators wanted everything both ways, criticizing Forbush for the practice of counting caterpillars and then criticizing him for not counting them.[41] Irritated by Kingsley's opinion that the difference between a systematic and an economic entomologist was a matter of common sense. Fernald told the investigators: "I am a systematic entomologist and also an economic entomologist, have been at work for many years, only I work for a few hours on systematic entomology. I turn, because my work calls for it, to economic entomology. As I sat there and listened to [Professor Kingsley] I tried to recall what sort of mental emotion I went through when I changed from one to the other, when I put off my common sense and worked as an idiot."[42]

Forbush, doing his best to refute the points made by his opposition, went down his list of detractors, mentioning his regret that Varnum Frost was absent because a "hearing without Varnum Frost [was] like the play of Hamlet with Hamlet left out."[43] Becoming increasingly emotional as the day went on, he appealed to the investigators for understanding, relating how he had worked "day and night" for the last several years, rising from his bed and leaving his house so early on a Monday morning he could not even say goodbye to his sleeping children, and returning so late at the end of the week that if his children were still awake he would have to be reintroduced to them. He said he had done his best under the circumstances and came to understand that suppression was "the utmost nonsense." He stated that those who thought the insect could be restrained with an expenditure of $50,000 annually were wrong. Always a fine public speaker, Forbush told the investigators that the moths were a great natural force as powerful as the ocean: "Take your hand off this thing and it will rise like a rising sea. . . . I believe in extermination, I know it can be accomplished, I know if it can be accomplished in one place it can in another; and I am working in that line and will so long as the money is given and I have anything to do with it. If I am not doing this thing right, if I am a scamp or a scoundrel, turn me out."[44]

The gypsy moth committee members, sensing the probable outcome of the investigation, made one last attempt to sway the legislature of 1900 by sending a written appeal through the investigative committee. In it, they claimed that gypsy moth extermination was "the broadest, most far-reaching, the most momentous question before any state legislature in the country" and warned that once the gypsy moth escaped, no power on earth would be great enough to stop it.[45] The acrimony between the two committees was so strong, however, that the investigators ignored the appeal, so the General Court never heard the board's final plea.

The gypsy moth committee tried to influence the public one last time with the publication of another article by Fletcher Osgood. "The Gypsy Moth in Massachusetts," which appeared in the *New England Magazine*, toned down the rhetoric and was more factual than Osgood's earlier effort in *Harper's*, "A State in Arms against a Caterpillar."[46] By the time the new article appeared in February, however, the investigators had largely made up their minds about funding the gypsy moth war.

On April 5, 1900, the wheel of the gypsy moth campaign came full circle. William Sessions became the last defender of the extermination experiment in testimony he gave alone before a joint session of the ways and means committee and the agriculture committee. Sessions maintained that the actions taken to exterminate the gypsy moth had been in response to public demand; he insisted that the Board of Agriculture had been reluctant to attempt the task,

completely forgetting that he and Nathaniel Shaler had been the driving force behind the effort to bring the state to war against the gypsy moth. He managed to chip away at the conclusions of the investigators but found himself saddled with the hopeless task of defending Fernald's years of inaccurate predictions and Forbush's huge and ineffective bureaucracy. Sessions stated that the committee would gladly relinquish its burden but made a plea to let the work continue: "If you call on us to lay [our duty] down, we shall relinquish it with pleasure; only, as our last word, we pray you, for the good of the State in the future, for the good of coming generations, let the work go on, and history will applaud the broadness of your foresight, the wisdom of your verdict."[47]

Quitting the Field

Upon receipt of the report from the investigative committee, the General Court voted against further appropriations for gypsy moth extermination. The Board of Agriculture's mandate to extirpate the insect was permanently canceled, and the remaining members of the workforce were let go for the last time. F. C. Moulton was hired for the year to collect all the tools and materials left after ten years of combat, make an inventory of them, and consolidate them at the storehouse in Malden. Through the year, Moulton also inspected portions of the infested region, a lonely figure with pad and pencil making his way across the hushed battlefields. The silence was not unsettling to Moulton, for as Osgood had noted in one of his articles, a striking feature of extermination work was the quietness with which it took place. Men swept back and forth through the forest for weeks, and except for calling out their tallies to their foreman every hour, they spent the entire day turning burlaps and killing larvae without speaking a word.

The Committee on Gypsy Moths, Insects, and Birds remained in existence and was required by law to make an annual report for the year. Members noted signs of the moth recovering the territory from which they believed it had been driven and listed areas in which the insect had made "great gains."[48] Malden, Everett, and Medford were generally infested; the moth's advance had been greatest in Melrose; it only lightly occupied Winchester, Arlington, and North Lexington. But in one yard owned by a Burlington market gardener, Moulton found thousands of nests, and elsewhere a total of fifty-one trees had died after being stripped for two consecutive years. The rapid rise in the moth's strength dismayed committee members, all of whom still believed in extermination and saw years of effort—"accomplished in the face of most discouraging difficulties"—slip away.[49]

The state made two final appropriations for gypsy moth work. An amount of $18,000, covering the period from January 1 to the end of April, 1900, was

used to pay the expenses of the committee members, the rents of the office, storehouse, and grounds, and the final wages of the fieldworkers, the adviser to the committee, and the director of fieldwork. At the the end of the year the sum also covered payment for Moulton's services, property rental, supplies, tools, printing, and the teaming, livery, and board of horses. On May 14, 1901, by Chapter 378 of the Acts of 1901, the Massachusetts General Court appropriated $1,000 and directed the Board of Agriculture to sell all its moth war–related property: "[to] dispose of said property on or before the first day of September in the present year, either by transferring the same to some state department or commission that may have use for it, or by sale at public auction."[50] The contents of the storehouse, including all the heavy spraying rigs and other large pieces of equipment, were transferred to the Metropolitan Park Commission (Sessions commented that since the assets of the Board of Agriculture had gone to another administrative arm of the state, the financial loss to the Commonwealth was minimized). In this ironic turn of events, the MPC became heir to the work that it had so diligently restricted. The remaining inventory was sold at auction and the money turned over to the state treasury.

The gypsy moth committee continued for a few more years, but it was a group without a mandate and with nothing to do. Not many of its reports, documents, maps, and other files, which were left with the Board of Agriculture in Boston for safekeeping, have survived. A few typewritten transcripts of the hearings were eventually bound into books and now repose in the special collections section of the Massachusetts State House Library in Boston. The Massachusetts Committee on Gypsy Moths, Insects, and Birds closed its books for 1900 on January 1, 1901, with a balance of $67.16.

Massachusetts had gone to war against the gypsy moths with great optimism, believing the conflict would be brief and the outcome certain. Instead, the fight against the insects lasted for more than ten years and became enormously expensive. The Commonwealth had appropriated $1,155,000 during the campaign, plus another $20,000 for work against the brown-tail moth. Charles L. Marlatt and others estimated that landowners, businesses, and homeowners expended an equal amount during the same period.[51]

The military aspects of the eradication campaign had been obvious, but the force sent against the insects was always too small and too poorly equipped to gain victory. Few realized just how much too small that army was. There were seldom more than five hundred men on the rolls, and the average number in the field at any given time was no more than half that. The Europeans, when dealing with similar pests such as the nun moth, would send three thousand regular army troops into a region of fifteen or twenty square miles,

concentrating more than six times the men in an area less than a tenth the size of the Massachusetts combat zone. The Germans, when confronted with caterpillar swarms in their forests, usually did not even attempt to save individual trees. Instead, they dug miles of trenches, allowed the caterpillars to crawl in, and then either set the insects ablaze with kerosene or simply buried them.

In Massachusetts the strain of combat had taken its toll on many in leadership positions, from Kirkland's period of excessive drinking to Forbush's several breakdowns to the resignations of committeemen Appleton and Shaler for their health and well-being. Fernald was glad the need to make frequent trips to Boston had ended; his rheumatism had become so severe that at times it almost incapacitated him. As he wrote to Leland Howard a few years later, the added duties placed on him during the gypsy moth campaign had nearly caused him to break down.[52]

Fernald, Howard, Sessions, and Kirkland had played their end game skillfully, parading their small contingent of economic entomologists back and forth across the ramparts until they looked like a battalion, but in the end their charade failed. It is perhaps the finest of ironies that the economic entomologists' war against the gypsy moth was lost because it had become uneconomical to continue fighting. The results achieved by economic entomology proved exactly the opposite of what had been hoped for, and the discipline was weakened considerably. Many entomologists had become like the blind men in the fable who discovered an elephant by taking hold of its tail. Most of them knew by the middle of the war that the cause could not be won with the means and technology at their disposal, yet they repeatedly urged the Commonwealth to continue the war on the basis of their opinions as professional scientists that victory was near. When it was no longer possible to ignore the San Jose scale in Massachusetts, Archie Kirkland wrote to Fernald that it would be "very difficult in any way to carry through insect legislation after the experience the legislature has had with the gypsy moth."[53]

The insects earned respect even from those who spent years trying to kill them. Osgood called the moth a "tough and hardy creature."[54] Forbush spoke of its "wonderful reproductive powers and its remarkable tenacity of life."[55] Howard noted that the insect was "wonderfully resistant to the action of ordinary insecticides."[56] And Fernald wrote, "They are very loathe to die, and will hang on to life with wonderful power."[57]

Ignoring the Lessons

The silence that Nathaniel S. Shaler accorded his four years on the committee is resounding. In his autobiography, Shaler, who was a prolific author and

diarist, does not mention Riley, Scudder, Forbush, or Fernald and not even Trouvelot himself, all of whom he knew personally. Neither does he mention the war against the gypsy moth nor the great eradication experiment. His involvement in the work is buried in a single sentence in Sophia Shaler's memoir, written after her husband's death: "The different state boards (the Highway, the Metropolitan Park, and the Gypsy Moth Commissions) upon which he served, and the mining organizations with which he was connected, filled up most of the hours left over from his college duties."[58] There is no record of Shaler having much more to do with the gypsy moth in any official or advisory capacity after his testimony at the hearings of 1900. He died in 1906 as the result of an infection following surgery to remove his appendix.

Leland O. Howard had penned more than his share of lines on the insect when motivated by his zeal to further the ends of economic entomology, but in his autobiography, *Fighting the Insects*, written in 1933 when he was seventy-five years old, he became positively spartan on the results of the great experiment. He frequently mentioned contemporaries such as Fernald and Riley in other contexts, and became loquacious when describing his trips abroad to collect parasites early in the twentieth century. Yet in this summation of his life's work the humiliating collapse of the gypsy moth campaign is accorded only a single passing reference with regard to a general question about the development of spraying machines that could operate on hilly terrain.

Charles Fernald was only too glad to rid himself of anything that combined politics and insects, and once the war was over, he wasted little ink on his experiences. Everything he wrote for public consumption after the turn of the century says the same thing in different ways, but privately Fernald remained disturbed and confounded by the outcome of events. He maintained for the rest of his life that the extermination of the gypsy moth was prevented at the last moment by the actions of the state legislature, although as time passed he did modify somewhat his stance on foreign parasites, writing in 1904:

> We were confronted by the fact that there is no known parasite in the world that confines its attacks to the gypsy moth alone, for if this were the case the prospect would be far different from what it is now. . . . The closing of the work by the legislature and the rapid increase and spread of the moth since that time has in all probability rendered extermination impossible. . . . It seems probable therefore that we would do well in the future to ascertain what advantage may now be obtained from our parasites and to satisfy the "general public" it may well [be time] to try the importation of parasites and predacious insects from Europe.[59]

After the collapse of the extermination campaign, Fernald's friend and former student Archie Kirkland left Boston to work in the pesticide branch of the Bowker Company in New York City, which by most accounts was not a happy time for him. When the Commonwealth of Massachusetts renewed the war on gypsy moths in 1905, Kirkland and the aging Fernald were once again brought together to prosecute the work—but that is a story for another time.

Edward Forbush, unlike most of the others, had worked against the gypsy moth in the field on a daily basis. Although Forbush wrote copiously on the insect in his official capacity as director of fieldwork and left some additional references in a few brief and informal presentations before the Association of Economic Entomologists, almost nothing of a personal nature is to be found after his period of service as field director. The biographical sketch written about him in 1928 by John Bichard May, his associate and successor in the division of ornithology, is the only surviving postwar document that mentions the battle.

This sketch, however, was written in honor of Forbush's seventieth birthday and his mandatory retirement from the Massachusetts Department of Agriculture, so it is a flattering, if somewhat inaccurate, tribute. Its forty pages include such things as a two-page genealogy of Forbush's ancestry and tend to dwell on his adventures as a young "naturalist." To cite one example, a recounting of a few days' experiences during an expedition to Florida spans four pages, while in contrast, the work against the gypsy moth, which occupied nine years of Forbush's life and nearly a quarter of his term of public service, is given just a bit more than a single page. And that small review presents a surprising revision of the campaign's priorities: it emphasizes strategies such as increasing the numbers of beneficial birds, testing native and foreign parasites, and investigating "every other conceivable enemy of the moth." Moreover, it says that the plan of the gypsy moth committee was to clear small "demonstration areas," an idea utterly absent from the surviving written history of the campaign. The topic of spraying commands a single sentence, and blame for the collapse of the effort is assigned to the "short-sighted policy" of the state legislature and to "petty politics."[60]

After the end of the first campaign, Forbush was eventually appointed to the post he had wanted all along—that of state ornithologist of Massachusetts—and the danger to birds from arsenical sprays became a question he had to consider from the opposite viewpoint. Although he tried to walk a path between his friends in entomology and his colleagues in ornithology, he gradually withdrew from the Association of Economic Entomologists, at first downgrading his membership from active to associate and then resigning altogether. Ultimately, he could no longer deny that using poison sprays and baits for insect control sometimes killed birds in numbers, and that the

extreme practices of laying waste entire tracts of forest drove away desirable birds so completely that it often took years for their populations to recover.

The Shadows of Medford

The gypsy moths retreated to their forest strongholds to emerge anew in following years; likewise the economic entomologists withdrew to their redoubts in the agriculture experiment stations to regroup but not to reconsider. With their individual jobs safe and the direction of their profession now established, they were not inclined to question the validity of their insect philosophy. The failure of the campaign was seen as being due to external factors in the legislature and the citizenry, not to anything wrong with their doctrine and fundamental beliefs. Fernald, Howard, Kirkland, and others quickly mended fences with their counterparts in other branches of entomology and for a while turned to more pressing insect problems such as the San Jose scale.

If the economic entomologists had suffered their first defeat, they had also experienced their first taste of real power, which they found addictive. In little more than a single decade since the creation of the agricultural experiment stations, these men had been catapulted from figures of questionable sanity who ran through the fields netting bugs to individuals who had the power to call down chemical drenchings in residential neighborhoods, suspend the rights of citizens, and have their rules and regulations given the power of law. As Herbert Osborn noted in his presidential address to the tenth annual meeting of the Association of Economic Entomologists: "The entomologist of the present bears a very different relation to the public than he did a quarter of a century ago. New knowledge and new responsibilities have come to him; whereas then his opinion was presented and received as a gratuitous matter to be experimented with if convenient, his dictum now carries the force of authority, and often has the support of state and federal law."[61]

When the time of insect danger came again, the economic entomologists would present their reconstituted extermination programs with greater sophistication than before. As Osborn had noted, one of the three great tasks that lay ahead for economic entomology was the "education of the people to appreciate this need."[62] He proposed to present instructions about future insect extermination programs so explicitly that citizens would have to follow them without deviation. He advocated the idea that schoolchildren should be trained to accept the views of economic entomology, views such as Howard's that insects were a danger and that wars against them were endless. Others took up this message and presented it so successfully that by the middle of the new century it might be fair to say that scarcely anyone in the country could remember a time when he or she did not loathe insects.

Epilogue

Almost every economic entomologist writing in the years that followed the end of the first campaign claimed that the gypsy moth had been nearly eliminated from eastern Massachusetts as a result of the actions taken against it. In fact, the gypsy moth was nowhere near eradication; these hardy insects were widely dispersed both inside and outside the boundary of 1891. The last words on the contention that the gypsy moth had been reduced to insignificance in Massachusetts go to Charles H. Fernald and his friend and field general, Edward H. Forbush. Speaking at the fifteenth annual meeting of the Association of Economic Entomologists in 1903, Fernald said that conditions after ten years of war were what they had been at the beginning, with gypsy moths occupying the original centers of infestation "in fair abundance."[1] In testimony before the joint investigative committee, Forbush admitted that the moths had actually "spread and increased, especially in the wood lands" constituting "the first points of invasion."[2]

A large gypsy moth colony in Providence, Rhode Island was already well established by 1898. Although it was not discovered until July 13, 1901, the known breeding dynamics of the moth indicate it was at least three years old.[3] The gypsy moth committee received this news with astonishment and disbelief, and for several years afterward the group contended that "the moth was deliberately taken to Providence and purposely scattered by some malicious or irresponsible person."[4] There was also a growing infestation in Newburyport, Massachusetts, which spilled across the New Hampshire border. This colony was also found in 1901, but given the habits of this moth, it had certainly been established before 1900. The sheer numbers of insects occurring just one year after cessation of the work and their distribution in two additional states convincingly rebut the arguments that they had been controlled, contained, and nearly exterminated.

The advance of the gypsy moth in New England during the next several years was slow but steady. In 1905 an infestation was found near a velvet mill in Stonington, Connecticut, although unaccountably not reported until the

Archie Howard Kirkland, circa 1905.
Special Media Services Division, National Archives & Records Administration.

following year. Authorities in the four infested states of Massachusetts, New Hampshire, Rhode Island, and Connecticut appealed to the federal government for help, and at the end of 1905 the first federal appropriation was made for work against the gypsy moth. The sum of $82,000 to be disbursed by Leland Howard through the U.S. Department of Agriculture, marked the beginning of a federal involvement in the gypsy moth war that continues into the present. Maine joined the list of infested states in 1906 when state and federal inspectors found gypsy moth egg masses in Kittery, Elliot, York, South Berwick, Wells, Kennebunk, and Kennebunkport, and, most unexpectedly, a single cluster on the grounds of the National Soldiers' Home in Togus, eighty-one miles from all other known locations.

The second campaign against the gypsy moth, begun in 1905, was marked by a hasty alliance of the USDA, which began a program of importing parasites under Leland Howard, and the Commonwealth of Massachusetts, which placed its new moth program under the control of Archie Kirkland. The arguments made for extermination, the confusion and misstatements about the moth, the exaggeration of its danger, and the frightful methods used to prosecute insect warfare were repeated almost without exception everywhere the insect appeared. The fight against the gypsy moth in Massachusetts, which under other circumstances might have remained an obscure piece of local history, now burgeoned into a national misadventure that would span the entire twentieth century.

The USDA's bureau of entomology undertook the importation and release of as many supposed parasites (technically, *parasitoids*) of the gypsy moth as could be found in Europe, Russia, and Japan. A group of federal entomologists located first in North Saugus and later in Melrose Highlands, Massachusetts, imported millions of parasites of more than forty species and released them into the wild without even cursory life-cycle studies. Without secure trials of any kind, some were sent to states far removed from those infested by gypsy moths to be used against other insects, and some were sent to Canadian entomologists for the same kind of experiment with no idea whether the insects would be effective, transmit diseases, or attack nontargeted species. Record-keeping during the importation period was lax and disorganized. William Fuller Fiske, the entomologist in charge of the labs, noted that no one was sure how many parasite species had been received—he thought the number was between forty and fifty—and no one was sure how effective they were. Fiske said that about thirty appeared to attack the moths, and about twenty were thought to be important.[5]

Howard's approach to natural control of the gypsy moth seemed desperate and was arguably reckless and irresponsible. He intended to release into North America every known insect adversary of the gypsy moth without exception, ignoring the potentially massive disturbance of natural balance on an entire continent and risking all consequences for the sake of exterminating one single species of insect.[6] One tachinid (fly) parasitoid he imported, *Compsilura cocinnata,* is a case in point. Howard knew that it hunted a large number of nontarget species in Europe and would likely do the same in the United States.[7] Howard released the insect anyway, arguing that the presence of alternative hosts would ensure the parasite's survival. He considered this an acceptable trade-off, even if the imported predator attacked every one of the "hundreds" of available domestic species.[8] Howard also knew that *C. cocinnata* would compete against native parasites with a high probability of success but took the detached view that the conflict would offer "a most excellent opportunity to answer numerous questions which naturally arise when this subject is considered."[9] Howard did not care if other caterpillars were attacked because he believed, as did almost all economic entomologists of his time, that only a handful of insects were directly useful to man and, except for the silkworm, that there was no such thing as a beneficial caterpillar.

An alignment of New England interests that wanted gypsy moth control with southerners who wanted control of the Texas cattle tick secured an unexpectedly large federal appropriation of $250,000 in the 1907 agriculture appropriations bill.[10] Some of this money was used to fund the parasite importation effort, which had become quite controversial. Prominent citizens of Boston claimed the government was moving too slowly, while an additional

dispute arose between proponents of the California method of natural pest control and the plans of the eastern entomological establishment to import parasites and continue spraying at the same time.

When Ellwood Cooper, who later became the California commissioner of horticulture, told the citizens of Boston he would send them a gypsy moth parasite that would accomplish what they desired if Massachusetts would put $25,000 in escrow to be paid to him only if the gypsy moths were controlled, the eastern entomological establishment was incensed. Leland Howard later called Cooper's claim "preposterous."[11] Kirkland said the proposals were "specious" and labeled the Bostonians who supported the idea as "dilettantes." The Californians, who thought the easterners were too reliant on spraying, responded by saying that any enormously expensive method that had to be repeated and was usually unsuccessful was "idiotic."[12] But the Californians were beaten back when the easterners used Fernald's old scheme of convening a congress of thirty sympathetic economic entomologists to affirm the eastern plan.

The federal approach under Howard emphasized the use of insects to fight insects, but the effort to import and establish foreign parasites was often disrupted by the outbreak of disease among gypsy moth and brown-tail moth populations. Among these was the wilt disease (nucleopolyhedrosis virus, or NPV) of the gypsy moth, which appeared in North America for the first time in 1907. No one knows how or where it was introduced, but it had likely come with the insects themselves. Although this and other naturally occurring and highly selective diseases promised to be outstanding control agents, their presence only frustrated those entomologists who viewed epizootics as major disruptions to their work with imported predator insects. Howard and state officials in Massachusetts created a small group of scientists to explore fungal and viral pathogens, but the effort was assigned a low priority and was not well funded; in fact, trips to Japan to collect samples of fungally infected caterpillars were made possible only upon receipt of anonymous private donations.

The work with fungal diseases, to which caterpillars are highly susceptible, uncovered strains for both the gypsy moth and the brown-tail that had the ability to sweep away entire populations. The problem with these pathogens was that once they were released into the wild, they could no longer be controlled, a condition unacceptable to economic entomologists because it made them superfluous. In the case of the brown-tail, disease would appear spontaneously in populations that had been targeted for artificial inoculation, and no one could tell whether the naturally or the artificially seeded spores caused moth mortality. A promising entomophagous fungal pathogen, deadly to the gypsy moth and highly selective in its action, was released into the wild near

Boston in 1910 and again in 1911, but it was so difficult to work with and the results were so disappointing that the project was abandoned and largely forgotten.

After five years of intensive efforts importing, breeding, and releasing parasites, federal entomologists concluded that they had done all they could. In Howard and Fiske's final report, published in 1911, some important conclusions were expressed or implied.[13] The first was that the plan to stop the spread of the gypsy moth with European and Asian parasites had failed. The second was that the gypsy moth was a forest insect and not an agricultural pest; therefore, the legendary suburban infestations of the 1890s in places such as Medford were unlikely to happen again, since the insects migrated away from populated areas into their preferred woodland habitat.[14] Howard put the matter in plainer terms when he wrote in *National Geographic*: "Neither the gypsy moth nor the brown-tail moth are longer to be feared as shade tree enemies or as enemies of orchards and gardens. Both have become regulated to the class of forest insects, so far as their ravages are concerned."[15]

The public was slow to grasp the consequences of the unfettered importation of alien species. As perpetrators of such acts, the worst offenders by far were not private entrepreneurs such as Leopold Trouvelot but the federal government itself and its ongoing policies of importing and distributing foreign plants and seeds. Agencies such as the U.S. Office of Plant Importation ultimately imported almost 200,000 foreign plants, some along with their own diseases and their insect pests.[16] In fighting the gypsy moth the bureau of entomology under Howard carried out the largest and most purposeful importation of alien insect species in the nation's history. Writers such as William Temple Hornaday, though he called the importation of the gypsy moth a "winged calamity," were beginning to question such practices: "The man who successfully transplants or 'introduces' into a new habitat any persistent species of living thing assumes a very grave responsibility. . . . The enormous losses that have been inflicted upon the world through the perpetuation of follies with wild vertebrates and insects would, if added together, be enough to purchase a principality. The most aggravating feature of these follies in transplantation is that never yet have they been made severely punishable."[17]

The use of arsenical sprays continued to rise despite the parasite program. In 1909 and again in 1910 the federal men in New England used five hundred tons of lead arsenate to combat the gypsy moth. Manpower needs were rising, too. The Massachusetts program under Kirkland employed 1,200 men during peak periods of insect activity in 1906; by 1910 more than 2,700 men were employed in gypsy moth work. Yet many of the scientifically supported assumptions underlying the work done against the gypsy moth in the 1890s had been disproved by the end of 1912. The practice of applying heavy oils and

flammable fuels such as kerosene to combat insects on trees was shown to damage the trees through their bark to a depth below the vital cambium layer. Oil sprayed on the ground to burn brush and leaf litter contaminated the soil and poisoned the plants at their roots. Fires across the brush and scrublands were discovered to harm the shallow-rooted tree varieties. Research showed that all substances previously used for banding trees prior to 1900 were injurious over time. Burning egg masses from tree bark with torches was invariably damaging. And evidence mounted that spraying did poison birds, if not directly, then indirectly.[18]

Nevertheless, mechanization of spray apparatus continued as Frank Rane, the Massachusetts state forester, introduced the first motor-truck-mounted sprayer in 1911, an invention that revolutionized insect spraying programs. The pump ran from a takeoff on the main engine and was powerful enough to throw at least two streams simultaneously to the tops of most trees. The costs of inventing new technology while supporting old technology in the war had risen markedly since the days of the first campaign, when $200,000 per year was considered a fat budget. As costs rose to a million dollars per year to fight the gypsy moth in New England, the end was nowhere in sight.[19]

Aside from importing parasites, the major work done by the state and federal agencies fighting the gypsy moth consisted largely of clearing roadside strips in the most heavily infested districts to prevent the larvae from spinning down and being carried away on vehicles. Despite a strenuous effort over a very wide area, however, pockets of gypsy moths kept appearing at some distance from the infested regions, a circumstance that was at first blamed on the growing number of gasoline-powered "horseless carriages." It was not until 1912 that the importance of wind dispersion was understood. Entomologists had known since the early days of the first campaign that the larvae could be blown by the wind, but the general consensus was that they were not blown far—perhaps no more than one hundred yards.[20] It dawned only slowly on some of the researchers that the prevalent theories about moth spread could not entirely explain all the infestations that were being observed. Under the right conditions the larvae could be blown much farther and in sufficient numbers to start new colonies miles away—which may partially explain how the gypsy moth reached the southeast corner of Vermont in 1912, marking the point in time when portions of all six New England states were infested.

In subsequent years the appearance of gypsy moths in areas where they had not been found before was not always referred to as an advance or a distribution but as "wind spread." The knowledge of wind spread led to a shift in tactics by the federal units in Massachusetts: they moved their bases of operation from the centers of the most heavily infested districts to the leading edge of the advancing moth legions, especially on the western front. A picket line

twenty-five miles wide was established in the middle of the state, and it was repeatedly, thoroughly, and unsuccessfully worked on to eliminate any colonizers that had blown in from the east. In reality, it was Shaler's old strategy of containment on the periphery, now expanded to a size the old scholar could never have anticipated.

On March 1, 1913, the federal gypsy moth work in the northeast was reorganized, and Albert Burgess was placed in charge of the entire New England region.[21] This same year, after passage of the Federal Plant Quarantine Act, the entire infested area was quarantined.[22] In order to move products and materials out of New England, inspectors had to certify that they were free of the gypsy moth in any of its life stages. Localized infestations were discovered in North Castle, New York, in 1914 and in Bratenahl, Ohio (a suburb of Cleveland), the same year, but these colonies apparently died out.[23]

By the start of the First World War, gypsy moths in Massachusetts alone could be found in an area of more than 2,500 square miles, and Kirkland noted that the central towns within the old boundary of 1891 were now completely infested. In other states the gypsy moth concentrations covered anywhere from five hundred square miles in New Hampshire to one square mile in Connecticut. Multiple invasions of Connecticut and New York occurred at the beginning of the 1920s. Nearly half a million dollars in combined state and federal funds were expended at this time to control the gypsy moth in Connecticut alone.[24]

The most worrisome expansion of the moth's territory was discovered on June 30, 1920, when workmen on the Duke estate at Somerville, New Jersey, discovered swarms of caterpillars feeding on evergreen trees. Thomas J. Headlee, the New Jersey state entomologist, noted that from the outset the size of the infestation indicated it was one of long standing. The European moth normally prefers deciduous trees, so the destruction of evergreens was a real scare. Subsequent investigations determined that egg masses of the moth, according to Harry B. Weiss of the New Jersey Department of Agriculture, had "probably" been introduced on European blue spruces imported from Holland in 1911 and that the insects were of the European variety that normally feeds on oak.[25]

Because the large New Jersey infestation was isolated, extermination was the only acceptable plan, and the insect was fought in the same detailed and painstaking ways that had been used in Massachusetts in the 1890s—with arsenical sprays, burlap, creosote, axes, and fire. Even though the infestation in New Jersey had declined by 97 percent on its own in one year, well before any work against the moths was begun, exterminative measures still persisted for ten years afterward at an expense of almost $2 million. Entomologists took credit for what they claimed was the first real elimination of the gypsy

moth but were never able to explain why the methods that had failed in every other place had succeeded in New Jersey. While New Jersey struggled to contain its first infestation, gypsy moth activity in the original bug-ridden areas of New England had finally begun to decline to the approximate levels of infestation noted in 1905.

At the end of the 1920s, functional cohesion of work against the moths had disintegrated, fragmenting into individual and uncoordinated efforts by federal, state, and local authorities as well as private individuals and organizations. Dexter Rogers and Albert Burgess on the federal team in New England noted in one report that any one gypsy moth agency seldom knew what any of the others was doing. In consequence, the number of people working against the gypsy moth at this time cannot be accurately tabulated, but it is likely numbered in five figures. So many men had worked against the gypsy moth over twenty-five years that it was possible to form experienced gangs in most eastern Massachusetts communities simply by calling for volunteers. The brown-tail moth, although still capable of producing large flights along the northeastern seaboard, was struggling against diseases, effective predators, and imported parasites. The Canadians reported serious problems with the brown-tail in the Maritime Provinces, but the moth's range seemed to be receding, and the infestations in New Brunswick and Nova Scotia had practically died out.

With the failure of the importation effort, work reverted to time-tested mechanical methods, and hope for success was transferred to the prospect of good results from silviculture as championed by Frank Rane. Rane's idea was to create "Black Forest" towns all over the Commonwealth where softwood forests would replace stands of susceptible hardwoods. Rane hoped ultimately to replant almost the entire state and create a vast, manmade woodland that would be impervious to the gypsy moth. Consequently, he and his state officers worked on logging off all the oaks in the Commonwealth and implementing a basic reforestation with pines and other resistant species, while Howard's federal men doggedly persisted in importing parasites and other schemes to contain the moth's advance.

Spraying continued to rise to higher levels each year. At one point during the First World War, Rane took delivery of an entire trainload of lead arsenate—twenty-nine boxcars.[26] He considered that this quantity, if carefully rationed, might be enough to supply his sprayers for a single season of eight or ten weeks. At the end of the 1920s, Massachusetts alone had a fleet of three hundred spray trucks. The economies of mechanized work had reduced the costs of spraying from thirty dollars an acre to six dollars an acre in many cases.[27] Once commercially produced truck-mounted sprayers became availa-

ble, the old horse-drawn units were retired and sold to farmers and other individuals for personal use.

As plan after plan failed, the job of the federal group largely became one of reporting the inevitable advance of the gypsy moth and moving the boundary line to a new location. The culmination of this practice came in 1923 with the establishment of the "Thou Shalt Not Pass" zone, at times facetiously called the "Verdun," "Hindenburg," or "Maginot" line. This barrier zone, twenty-five to thirty miles wide, extended for 250 miles along the Hudson River from Long Island, New York, northward to the Canadian border and contained about eight thousand square miles of land. The zone was the idea of Leland Howard, who saw the Hudson River valley in eastern New York as the last and best natural barrier to contain the moths in New England.

Between the Connecticut River valley in central Massachusetts and the Hudson River valley in eastern New York, the Berkshire Mountains constituted the heart of the extermination zone. Those familiar with the Berkshires would be astonished that anyone thought it could be defended against an insect with the habits of the gypsy moth. Its rocky and steep terrain was extremely favorable for the moth, inhospitable to men on foot, and impossible to cover with the mechanized equipment of the day. Yet despite the economic depression of the 1930s, millions of dollars were poured into the extermination effort annually, and in some years more than three thousand men were continuously employed.[28] The roster was filled from welfare rolls with inexperienced workers who were sent into the field after just two weeks of training.[29]

At the time it was defined, the zone was already known to be infested in many places and presumed to be infested in many others, making any claim that it would be an effective barrier somewhat suspect right from the start.[30] During its entire period of existence, the zone was never fully inspected, and Burgess, the federal entomologist in charge, acknowledged that it always harbored hundreds of active colonies. The great New England hurricane of 1938 was blamed for its destruction and the dispersion of the moth beyond it, but this assumption must be seriously questioned. In 1925, G. W. Herrick of Cornell University, in his book *Injurious Insects*, noted that gypsy moths could be found in most of eastern New York, an observation also made by Connecticut entomologist Neely Turner in 1922. Significant moth infestations had been reported in New Jersey and Pennsylvania even before the hurricane, and the moth had already made an end run around the line in Canada. The barrier zone was abandoned a few years after the hurricane, but some entomologists tried for years to have it reestablished, even after the moths had spread westward well beyond the Hudson River valley.[31]

World War II and DDT

The Second World War relegated the gypsy moth war to the back burner, but work against insects in general took on a high military priority, once again stirring up the battlefield mentality of many economic entomologists. In his book *War and Nature*, Edmund Russell showed how the methods used by entomologists to exterminate insects and the development of chemical weapons to exterminate humans through both world wars took on a frightening similarity.[32] Ironically, records kept by the USDA reveal that during the period of the Great Depression and the Second World War, gypsy moth activity declined to very low levels in all the infested states, even though little work against the insect was being done. Some entomologists suggested the barrier zone as a possible reason for this lull.[33]

It was during the Second World War that an astonishing new pesticide called DDT was developed and put to use with spectacular results. DDT killed almost every insect it touched, and when sprayed on surfaces it would persist effectively for months. In the unnatural conditions caused by war, the new insecticide was highly effective at eliminating body lice and the insect vectors of war diseases such as yellow fever, typhus, and malaria. Spraying programs thus saved many lives in areas where the destruction of water supplies, food stores, and hospitals, along with concentrations of weak and undernourished refugees living in unsanitary conditions, had created conditions favorable for the spread of disease. As a result, this caused many Americans to believe that the three greatest things to come out of the war were "the three p's,"—plasma, penicillin, and pesticides.

Discussions about the use of DDT dominated meetings of the Association of Economic Entomologists. Its 1944 meeting in New York was referred to for years afterward as "the DDT meeting" because of the preponderance of papers on the new insecticide. High-level government planners were envisioning a peacetime war against the gypsy moth, a decision not altogether surprising, since a philosophy of unending war against insects had been part of economic entomology's underpinnings from its inception in 1889.

In postwar America, federal programs against insect pests were resumed with a fervor and zeal that went far beyond anything known before. A vigorous chemical industry had emerged from the war with a great production capacity and desire to expand its markets, and a giant federal bureaucracy stood willing to accommodate it. Moreover, war surplus planes that could be easily converted for aerial spraying were numerous and inexpensive, and there was a willing corps of recently discharged pilots ready to fly them. In one hour, one pilot in one spray-equipped C-47 could cover an area that would have taken nine heavyweight hydraulic ground units and their crews all

season. A single planeload of insecticide could treat an area as large as one truck-mounted apparatus could treat in four years and do so at a twenty-fifth of the cost. Leaders who were not afraid to drop the atomic bomb on human adversaries in cities were manifestly undisturbed by using DDT, the atomic bomb of pesticides, against insect adversaries in the nation's eastern forests.[34]

The appearance of DDT and its variants along with the new air war against the gypsy moth ended the lead arsenate era almost overnight. The old-fashioned hydraulic sprayers were retired; cyclone burners disappeared from the scene. The once-ubiquitous burlap bands had been dismissively referred to as "petticoats" for years, even though they had never lost their effectiveness. The caution owed to any new and terrible formulations for use against insects seemed all but gone. The thinking in applied entomology championed the idea that all available technology should be used, no matter how horrible.

For more than a century, the American population had been flowing from rural farm areas into the great cities. After the war the tide reversed, and individuals poured outward from the cities to establish a new lifestyle in the suburbs. The resulting sprawl in the Northeast, creating communities in places where the gypsy moth was either approaching or was already present, once again made what was essentially a forest insect into a pest of town parks, school playgrounds, residential backyards, flower and vegetable gardens, tree-lined boulevards, and specimen plantings. But this time, in the collision of humankind and the insect, pesticides that were not arsenic-based separated citizens of the twentieth century from their counterparts of the previous century.

Arsenic was an old poison, and the average man and woman in nineteenth-century Massachusetts could never be persuaded that it was not dangerous. In comparison, so little was known about DDT that neither entomologists nor chemists of the time understood how it worked. Between an absence of knowledge about modern insecticides, on one hand, and a flood of propaganda that reported only their benefits, on the other, the average citizen lost his fear of the chemical. Reassured at every turn that the modern formulations were deadly to insects but harmless to humankind, a substantial number of individuals began to demand that their homes and surrounding environments be kept free of such insect pests as the gypsy moth.

Between 1946 and 1952, aerial spraying was done everywhere the gypsy moth could be found. Delivery systems were refined to allow planes to remain airborne longer and apply the spray in wider swaths over greater areas. Broadcast sprayings over entire forests took place, including their lakes, rivers, and streams. Multiple sprayings were common, regard for overspray and drift did not exist, and the effects of pesticide residuals and breakdown products were

not even considered. Despite it all, it seemed the gypsy moths would never be dislodged.

Then something almost miraculous took place: traps set in Pennsylvania and New Jersey during the summer of 1952 did not catch a single male moth. Nothing even remotely comparable had occurred in sixty years of combat. Officials credited their eradication programs and declared the two states free of moths. Millions of acres had been suddenly recaptured from a previously invincible enemy. The gypsy armies in those states had not only been driven off; they had been obliterated down to the last individual—convincing proof that the chemical war against them could be won. Optimistic plans were drawn to eradicate the moth from New York and Connecticut. After that, the invaders would be pushed back into Massachusetts.

Not all government entomologists were convinced that such plans were wise when viewed against ominous reports coming from the field. Some, like Frank E. Todd and S. E. McGregor, noted that the ever increasing use of pesticides had driven beekeeping out of many apple-growing areas and had "nearly wiped out the bee industry" in cotton-producing states.[35] Further, so many other insects had become resistant to DDT so quickly that government entomologist W. N. Bruce wrote in 1952, "The usefulness of DDT and other chlorinated compounds is coming to an end."[36] Without yet knowing of the damage done to birds, fish, and the environment, and ten years before Rachel Carson's *Silent Spring* was published, a small but growing group of field entomologists already understood that the low numbers of insects did not signal victory, and that when the inevitable insect advance resumed, it likely would comprise highly resistant individuals against which even the deadliest pesticides would not work.

To ensure total destruction of the enemy, federal entomologists intended to soak the northeastern forests in a rain of pesticides that not even the legendary hardiness of the gypsy moth could withstand. John Corliss, chief of the USDA division of gypsy and brown-tail moth control, believed that planes and sprayers could completely eliminate the moth. He smelled victory in the oily, pesticide-fouled air. "Current objectives are to conduct trapping and scouting surveys in Pennsylvania until extermination there is assured," he wrote confidently in 1952, "eliminate general infestation in New York by 1953 with only mop-up of isolated incipient infestations remaining in succeeding years."[37]

In post–World War II America, few entomologists thought any longer of natural controls for the gypsy moth. Some estimates are that within two decades, more than nine out of ten economic entomologists were working directly or indirectly for chemical pesticide manufacturers, while less than 2 percent of field entomologists were actively researching natural controls for any insect.[38] As one entomologist succinctly put it, "Biological control work

was dropped."[39] The shortage of individuals with experience in natural controls was so acute that in 1966, when the chemically resistant cereal leaf beetle invaded the upper Midwest, a facility created in the southern Michigan city of Niles to research biological control of the beetle had to recruit technicians from among retirees and housewives living in the area.[40]

The heady days of the new gypsy moth campaign did not last long. Under pressure from the intense post-World War II sprayings, the insect expanded its range dramatically, and as repeated drenchings with pesticides indiscriminately killed the predator populations so painstakingly set out thirty years earlier, moth populations rebounded. The imbalance of nature continued with memorable results. In 1950s Europe a gypsy moth outbreak might defoliate five hundred acres; in 1950s America it might defoliate fifty thousand acres.

By 1955, with the war against gypsy moths not going well, spraying increased to a frenzied level that would not be matched again for thirty-five years. Aircraft pilots were paid according to the number of gallons sprayed, and there was little to dissuade these aviators from putting in long days with fully opened valves or from spraying the same areas more than once.[41] In 1957, New York, New Jersey, Michigan, and Pennsylvania, in conjunction with the U.S. Department of Agriculture, aerially sprayed more than three million acres of forest to "eradicate the gypsy moth from the periphery of the infested area and suppress them in the center"[42]—a strategy similar to the one unsuccessfully used in Massachusetts sixty years earlier. Spraying also occurred in other northeastern states, and some prominent state entomologists, including Neely Turner and J. Gordon Horsfall in Connecticut, became so appalled at the rage against the gypsy moth that they refused to endorse the government plan.[43]

Aerial spraying occurred with increasing frequency over heavily inhabited areas of the Northeast. In one case that borders on the surreal, the New York state and federal departments of agriculture, citing an implausible threat from the gypsy moth to New York City and environs, announced plans to spray densely populated Nassau County, Long Island, with DDT in fuel oil.[44] In 1957 a group of thirty residents seeking an injunction had their case heard by Judge Walter Bruchhausen in the U.S. District Court for the eastern district of New York. After Bruchhausen denied a temporary injunction, the spraying took place. The plaintiffs pursued the case to the U.S. Court of Appeals, hoping to obtain a permanent injunction, but the case was dismissed in 1959 because injunctive relief was moot. In 1960 the U.S. Supreme Court declined to hear the case, though Justice William O. Douglas strongly dissented.

Although the plaintiffs lost their case, they won a publicity bonanza that sobered the entomological profession. Others concerned about the dangers of pesticides were encouraged to explore legal remedies, and the number of law-

suits filed began to increase.[45] The compelling testimony given by the plaintiffs' witnesses resulted in a trove of information that attracted a fifty-one-year-old marine biologist named Rachel Carson who was writing a book about the dangers of indiscriminate pesticide use. Russell notes that for her book, Carson "[drew] largely on evidence presented at the trial."[46]

Following the 1957 spray turmoil the USDA, with little explanation, abruptly called a halt to massive forest sprayings for gypsy moths in the northeast and turned its sights on the fire ant in the South. Both the fire ant and gypsy moth programs, however, caused the public to become concerned over aerial spraying, and opposition to insect eradication programs began to manifest in diverse institutions—from the National Audubon Society to the U.S. Congress—while magazines such as *Reader's Digest*, *Life*, *Saturday Evening Post*, and, improbably, *Sports Illustrated*, questioned the practice in print.[47]

Houghton-Mifflin published Rachel Carson's *Silent Spring* in 1962. The book remained on the best-seller list for more than thirty weeks and was continuously in print for more than forty years. Carson's level tone and well-researched warnings resonated across the entire nation and so strongly raised the American consciousness that former vice president Al Gore called it "the beginning of the modern environmental movement."[48] Several important developments occurred largely because of *Silent Spring*. Spraying DDT for gypsy moths was discontinued in 1966, and the Environmental Protection Agency (EPA) was created in 1970. Pesticide approval and regulation was removed from the USDA to the EPA, at last weakening the agricultural philosophy that had gripped the gypsy moth program for more than eighty years. In 1971 the USDA ordered a cessation of all "blanket spraying of huge uninhabited woodlands."[49]

In 1975 the National Academy of Sciences published a series of books on pest control. In the fourth volume, *Forest Pest Control*, a forest study team chaired by Richard S. Miller of Yale University noted that all the state and federal agencies responsible for combatting the gypsy moth had finally conceded that the insect, after one hundred years on the North American continent, had become a naturalized part of the forest fauna. The book also pointed out that the gypsy moth had been found as far west as California.[50]

Sentiment against gypsy moth programs continued to rise and manifest in actions against spraying, as New Jersey entomologist J. D. Kegg wrote in 1978:

> The pesticide controversy has resulted in an anti-spray sector which consists of outspoken individuals, special interest organizations, legislators and administrators, who through their own power or the use of the court system, can severely curtail gypsy moth spray operations.

> For example, laws limiting spraying against the gypsy moth have been passed in Connecticut and a new administration in Albany has greatly curtailed spray operations in New York. Even within the federal government we have agencies opposing gypsy moth chemical control in heavily infested forests.[51]

The summer of 1981 was the nadir of the struggle against the gypsy moth, a time when the insect seemed unstoppable and when its voracious habits resulted in the "defoliation" of thirteen million acres[52]—the greatest damage to trees ever caused by a single insect species in the United States.[53] The treatments, the trappings, the pesticide sprayings and everything else humans had tried had failed utterly to control the moth or even appreciably diminish its numbers. Foresters, entomologists, and officials at all levels could only watch helplessly as the ravages of nature seemingly gone berserk unfolded before their eyes. The caterpillars were everywhere in frightful numbers, moving relentlessly through New York, New Jersey, and Pennsylvania toward the great hardwood forests of Appalachia.

Pennsylvania was one of the two states most affected in 1981 (the other was Massachusetts). The first report of the gypsy moth in the Keystone State came in 1932, when the insects were discovered in Luzerne County. They quickly spread into every county, and by 1972 the state's department of environmental resources was spraying heavily to control the invaders. Unlike the early infestations in Massachusetts, where authorities had to contend with areas several hundred acres in size, by the early 1970s estimates were that the moth was active in over two million acres in Pennsylvania and moving generally south. Even those few million acres in Pennsylvania might have been considered a manageable area, but by 1975 the gypsy armies in the United States had extended their range to over 200,000 square miles. The forests of south-central Pennsylvania were heavily defoliated by the gypsy moth again in 1982 and 1986. The chemical weapon most relied on by Pennsylvania authorities was trichlorofon (Dylox), which proved so dangerous that the state ceased using it in 1983 and switched to Dipel, a product based on a naturally occurring moth pathogen, *Bacillus thurengiensis*.

The work of R. W. Campbell in the 1960s and 1970s doubtless underscored the sense of frustration that arose as a result of the astonishing successes of the gypsy moth against all adversaries. Campbell analyzed data available for the years 1911 to 1931 and came to the gloomy conclusion that as gypsy moth populations became denser and more widespread, outbreaks would become more severe and could last for ten years or longer. Campbell pointed out that science and the profession of entomology still had few tools available to deal with the gypsy moth, the only option was either to do nothing

and hope some naturally occurring phenomenon would halt an outbreak, or to continue spraying wherever it was arguably needed in the knowledge that such actions would not solve the problem.

Back to the Future

From this point onward the story of the gypsy moth in America becomes so diffuse that it is difficult to follow. The spread of the insect, however, is well documented. The front wave of the advancing moths passed quietly into Rock Creek Park in Washington, D.C. in the late 1970s, and during the 1980s the insects moved into Maryland, southern Virginia, eastern West Virginia, and northern North Carolina. Gypsy moths are increasingly found in Ohio, Michigan, Wisconsin, and other states of the Midwest. By 1994 they had established footholds in Arkansas, Tennessee, and Georgia. At present the gypsy moth has been reliably reported in almost every state of the union, including western states such as Washington and Oregon, where the Asian variety of the moth has occasionally been found.

The gypsy moth remains the only forest insect regulated by a USDA domestic quarantine. Many entomologists believe that no other forest insect has been studied so thoroughly or subjected to such unremitting eradication efforts.[54] No other forest insect has had so much money spent on it, and there is a good chance that the gypsy moth is the most expensive insect of any kind—with the possible exceptions of the cotton boll weevil and the spruce budworm.

A review of the current condition shows that the nation is still living with the consequences of decisions made almost a century ago with regard to importing predatory insects. This practice continues into the present on a smaller and more opportunistic scale, but the search for gypsy moth parasitoids and predators has been made in practically all parts of the globe where the insect can be found. During the campaign of the 1890s, any work in nonchemical approaches to insect control was dominated by the policies of Charles Fernald, and history seems to have proved him right in his decision not to import foreign parasites. He was concerned about the danger of secondary infestations and possibly feared other unforeseen consequences, as revealed by his comment that the idea was like a skimmer with too many holes in it.

In New England today, only nine of the original forty-seven imported gypsy moth predator species remain active, and only one, *Compsilura cocinnata*, is credited with suppressing the brown-tail moth so heavily that it exists at present only in small enclaves on islands off the coast of Maine.[55] There is a dark side to this phenomenon, however. Some foreign imports turned out to prey on other species whose reproductive capacities had not evolved to balance such great losses. Once loose in the field, the advance of *Compsilura cocinnata*

outpaced that of the gypsy moth because it found many alternate hosts in native North American insect populations. Today, entomologists know that *C. cocinnata* attacks almost one hundred other insect species. At present, the populations of some of North America's largest and showiest moths have been so deeply depressed by this foreign parasite that it has caused alarm in entomological circles.

Still with us in modern times is the concept of the barrier zone, which in its present manifestation is a variant of the 1890s encirclement strategy. The current zone, from North Carolina to the Michigan peninsula, was established as part of the "Slow the Spread" (STS) program begun in 1993. The goal of STS is to decrease the rate at which the gypsy moth moves into new areas. The expectation is likely the same one common to all barrier zones: to buy time until some newer or better method can be devised. But the usefulness of STS is immediately questionable, since the gypsy moth is constantly discovered at varying population levels in locations all across the country.[56]

Although the gypsy moth is a forest insect, almost no state sprays large woodland tracts any longer. Yet the claim that the gypsy moth will defoliate forests and kill all the trees is still heard today in places where the moth is first appearing—as are claims that were made in Medford more than one hundred years ago, that the gypsy moth is an alien species with no natural enemies—for it is in these areas that the bulk of present-day gypsy moth programs take place.[57] Evidence confirming the improbability of massive tree mortality is abundant but ignored, since it tends to reassure the public when those promoting spraying would prefer otherwise. A ten-year study in Connecticut beginning in the 1970s revealed that average tree mortality was less than 4 percent in forest stands that had suffered two successive years of defoliation, leading the researchers to conclude that gypsy moth infestations do not destroy forests.[58]

Even in the worst case, nature provides benefits. In Pennsylvania, which suffered much tree mortality during the 1980s, a thoughtful reassessment made fifteen years later by the U.S. Forest Service and the Pennsylvania Department of Natural Resources concluded that state forest lands in the formerly infested regions had become less susceptible to future destruction by the gypsy moth. Although the percentage of oaks had declined, the composition of the forests had become more diverse, and the order of tree succession observed in these areas provided habitat for wildlife species under stress from the lack of young forest ecosystems.[59]

The story of the gypsy moth in America has been one of nearly unremitting sameness interspersed with surprising and fateful events. One such incident occurred in 1989 when a fungus spontaneously appearing in Connecticut had spectacular results against gypsy moth concentrations. Work by Joseph Elk-

inton of the University of Massachusetts at Amherst and Anne Hajek of the Boyce-Thompson Institute at Cornell University in Ithaca, New York, ultimately proved that this fungus was *Entomophaga maimaiga*, and that it was the same genetic strain that had been seeded near Boston in 1910 and 1911.

What had happened to this fungus over the interim decades will probably never be known. *Entomophaga maimaiga* is distributed by the wind and can spread up to four hundred miles in a single year. It also is unusually hardy, having been known to survive as a resting spore for a decade or more. Yet even this longevity would fall far short of the seventy-seven-years between its original seeding in Boston and its reappearance in Connecticut, which suggests that the fungus may be naturally or otherwise reintroduced from time to time.

It is thus an outstanding natural control that many believe will help reduce the gypsy moth problem in America to a point where it is no greater than it has been in Europe. In places where the fungus has been artificially seeded, results have been exceptional. Bacteria and viruses exert control over the gypsy moth only when certain conditions are present including high population densities, insufficient food, and stressed or weakened colonies. The fungus, however, is effective at all densities and most conditions if sufficient moisture is available, and once released, requires little further attention. It is hard to overlook that the one potential control given the least attention by several earlier generations of entomologists has turned out to be the most important.

With the appearance of the fungus, the vast bureaucracy that has grown up around the gypsy moth is beginning to crumble. The myths of gypsy moth invulnerability and the absence of natural predators have at last been punctured. Priorities at the beginning of the twenty-first century have shifted; political pressure for moth extermination has diminished; scarce financial resources are being allocated to other programs; and many of the individuals who once specialized in the gypsy moth are moving into other areas of study.

There is little doubt that in the future the gypsy moth will appear in numbers from time to time and on occasion may even cause damage to trees. There is no less doubt that the insects will die down or move on again, and the natural cycle will continue as it always has. As horticulturalist Liberty Hyde Bailey said more than one hundred years ago: "After a time, a check will come. The potato beetle has already passed its zenith. The codling moth and the curculio have lost much of their fury in the east. The enemies of insects increase as well as the competitors. Parasites, finding innumerable insects on which to prey, increase with great rapidity, until they devour their own means of support. They, in turn, succumb, and the defeated host rallies; so the alternate warfare goes on forever. Witness how the tent caterpillars come and go."[60]

Notes

Abbreviations

BSNH	Boston Society of Natural History Archives, Lyman Libray, Museum of Science, Boston, Massachusetts
CM	Commonwealth of Massachusetts
CM-BA	Commonwealth of Massachusetts, Board of Agriculture
CM-GC	Commonwealth of Massachusetts, General Court
CM-House	Commonwealth of Massachusetts, Legislature, House of Representatives
CM-MPC	Commonwealth of Massachusetts, Metropolitan Park Commission
EML	Ernst Mayr Library, Special Collections, Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts
MSA	Massachusetts State Archives, Dorchester
MSH	Massachusetts State House Library, Boston
SIA	Smithsonian Institution Archives, Washington, D.C.
UMA	W.E.B. Du Bois Library, Special Collections and Archives, Charles H. Fernald Collection, Record Groups 40, Series 11, University of Massachusetts Amherst
USDA	United States Department of Agriculture

Introduction

1. Kim Todd, *Tinkering with Eden*.
2. Swade, *Difference Engine*.
3. Terms of office did not become two years in length until the 1920s; four-year terms were instituted in the 1960s.
4. Foster and O'Keefe, *New England Forests*, p. 8.
5. Graham, *Dragon Hunters*, p. 66.

1. Years in the Shadow of Science

1. N. S. Shaler testimony, CM-GC, *Hearing before the Joint Special Committee*, pp. 317–18.

2. Trouvelot, quoted in Leighton, "New England Butterflies," pp. 171–72.
3. Trouvelot, "Use of Antenna in Insects," p. 196.
4. Hubbell, *Broadsides from the Other Orders*, p. 175.
5. "Cost of Fighting a Pest," *New York Times*, May 1, 1897.
6. "E. Leopold Trouvelot," *Nature* 52 (1895): 11.
7. CM, Birth Records.
8. Trouvelot to Scudder, September 20, 1869, BSNH.
9. Trouvelot to Scudder, September 26, 1869, BSNH.
10. Lawrence, *Proceedings of the Two Hundred Seventy-fifth Anniversary*, p. 55.
11. Barrett, *Historical Sketches*, p. 31.
12. Liebhold, Mastro, and Schaeffer, "Learning from the Legacy of Leopold Trouvelot," p. 20.
13. Osgood, "Gypsy Moth in Massachusetts," p. 677.
14. Wood testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 84.
15. *Federal Census for Massachusetts*, 1860, microfilm spool 16, p. 631.
16. *Federal Census for Massachusetts*, 1870, microfilm spool 20, p. 401.
17. CM-BA, *Thirteenth Annual Report*, pp. 104–5.
18. Samuels, *Birds of New England,* p. 156.
19. Howard, *Gipsy Moth in America*, p. 7.
20. Herman and Corbin, "Leopold Trouvelot," p. 1.
21. Sorensen, *Brethren of the Net*, p. 5.
22. Lurie, *Louis Agassiz*, p. 197.
23. Museum of Comparative Zoology, [Fifth] *Annual Report* (1863), pp. 24, 28.
24. Museum of Comparative Zoology, [Sixth] *Annual Report* (1864), p. 23.
25. Boston Society of Natural History, *Proceedings* 2, (1866–68): 118–120. See also "Proceedings of Scientific Societies." *American Naturalist* 1, no. 1, p. 56.
26. Howard, *Gipsy Moth In America*, pp. 7–8.
27. Trouvelot, "American Silk Worm," p. 32.
28. Packard testimony, CM-GC, *Hearing before the Joint Standing Committee*, p. 1.
29. Trouvelot, "American Silk Worm," p. 146.
30. Samuels, *Birds of New England*, p. 156.
31. Ibid.
32. CM-BA, *Thirteenth Annual Report*, p. 116.
33. Ibid.
34. Trouvelot to Scudder, March 18, 1869, BSNH.
35. Trouvelot to Scudder, September 26, 1869, BSNH.
36. Wilder, Burt G., "Unwelcome Guests of Insects," p. 471.
37. Trouvelot to Scudder, April 11, 1868, BSNH.
38. Riley, *Fourth Annual Report*.
39. Peigler, "Wild Silks of the World," pp. 154–55.
40. Townend Glover, quoted in Howard, *History of Applied Entomology*, p. 39.

2. The Gypsy Moth Comes to America

1. Trouvelot, "American Silk Worm," p. 149.
2. Shaler, testimony, CM-GC *Hearing before the Joint Special Committee*, pp. 317–18.
3. Trouvelot to Scudder, March 30, 1867, BSNH.
4. CM-BA, *Thirty-eighth Annual Report*, p. 59.
5. Guberlet, *Windows to His World*, p. 166.
6. Howard, *Gipsy Moth in America*.
7. Haushalter to Kirkland, August 4, 1896, Box 2, Folder 72, UMA. "Caterpillar cholera" was a term used at the time to denote the *Wipfelkrankenheit*, or wilt disease, of the gypsy moth. It is likely the *nucleopolyhedrosis* virus. Haushalter probably misunderstood the name of the Parisian supplier, whom Trouvelot said was [Felix Edouard] Guerin-Meneville, the noted naturalist, entomologist, and author.
8. Wright, CM-GC, *Hearing before the Joint Special Committee*, p. 630.
9. Trouvelot to Dall, May 1, 1870, Record Unit 7073, Wm. H. Dall Papers, circa 1839–1858, 1862–1927, Box 16, Folder 39, *SIA*.
10. Gerardi and Grimm, *History, Biology, Damage and Control of the Gypsy Moth*, front flap.
11. Trouvelot, "The American Silkworm," *American Naturalist*, April 1867, p. 85.
12. Gerardi and Grimm, *History, Biology, Damage, and Control of the Gypsy Moth*, p. 136.
13. Boston Society of Natural History, 11 *Proceedings* (1866–1868) p. 89. There is some unresolved confusion about this date: the meeting at which Trouvelot spoke was held on November 28, 1866, but Trouvelot wrote in the *American Naturalist* that he sailed for Europe on November 2, 1866.
14. Trouvelot to Scudder, May 11, 1867, BSNH.
15. Trouvelot, "On a Method of Stimulating Union, pp. 136–37.
16. Ibid., p. 136.
17. Ward, "Agricultural Experiment Station," p. 67.
18. Osgood, F., "State in Arms against a Caterpillar," p. 458.
19. Forbush and Fernald, *Gypsy Moth*, p. 4.
20. Ibid., pp. 3–4.
21. Henshaw, to Fernald, September 17, 1889, Box 8, Folder 209, UMA.
22. Haushalter to Kirkland, August 4, 1896, Box 2, Folder 72, UMA.
23. Riley, *Second Report*, p. 10.
24. *Insect Life* 2, nos. 7 and 8 (1870): 208.
25. Shaler, *Kentucky Geological Survey*, 1875.
26. Shaler, testimony, CM-GC, *Hearing before the Joint Special Committee*, pp. 317–18. See also Forbush and Fernald, *Gypsy Moth*, App. A.
27. Fernald, "Notes on the Gypsy Moth," p. 59.
28. CM, [First] *Annual Report of the Superintendent for Suppressing the Gypsy and Brown-tail Moths* (1905), p. 9.

29. Trouvelot to Dall, May 1, 1870, Box 16, Folder 39, SIA.
30. Ibid.
31. Trouvelot to Scudder, September 26, 1869, BSNH.
32. Samuels, "Summer Entomology," pp. 402–3.
33. Packard, "Hessian Fly: Its Ravages, Habits and Means of Preventing Its Increase," *U.S. Entomological Commission Bulletin* no. 4, (1880), in Pauly, "Fighting the Hessian Fly," p. 381.
34. Scudder, *Butterflies of the Eastern United States*.
35. Scudder, "Notes on Drawings." See also Scudder, *Butterflies of the Eastern United States*, 1: xi.
36. *Cambridge City Directory for 1873*, p. 372.
37. *Annals of the Astronomical Observatory of Harvard College*, 8:3.
38. "Editor's Scientific Record," p. 908.
39. "History of a Publishing House," p. 798.
40. "Trouvelot, E. Leopold," in *Dictionary of Scientific Biography*, 8: 472.
41. Trouvelot, to Dall, May 1, 1870, Box 16, Folder 39, SIA.
42. Forbush and Fernald, *Gypsy Moth*, p. 4.
43. Haushalter to Kirkland, August 4, 1896, Box 2, Folder 72, UMA.
44. Riley and Howard, "Imported Gypsy Moth," pp. 208–9.
45. Samuels, *Birds of New England*, p. 156.
46. Trouvelot to Dall, May 1, 1870, Box 2, Folder 72, UMA.
47. Trouvelot to Scudder, March 18, 1869, BSNH.
48. Trouvelot to Dall, May 1, 1870, Box 2, Folder 72, UMA.

3. The Caterpillars Are Coming!

1. W. R. Taylor, CM, *Statements from Eye-Witnesses*.
2. CM-BA, *Report on the Work of Extermination* (1895), p. 40.
3. W. R. Taylor, CM, *Statements from Eye-Witnesses*.
4. Forbush and Fernald, *Gypsy Moth*, p. 10.
5. CM-BA, *Report on the Work of Extermination* (1895), p. 38.
6. Forbush and Fernald, *Gypsy Moth*, p. 6.
7. J. S. Cotton, CM, *Statements from Eye-Witnesses*.
8. M. Belcher, ibid.
9. CM-BA, *Report on the Work of Extermination* (1895), pp. 40–41.
10. D. M., Richardson, *Statements from Eye-Witnesses*.
11. S. Lacy, ibid.
12. CM-BA, *Report on the Work of Extermination* (1893), p. 16.
13. J. O. Goodwin, testimony, CM-GC, *Hearing before the Joint Standing Committee*, p. 7.
14. "Army of Squirming Worms," *Boston Herald*, May 27, 1889, p. 9.
15. W. C. Craig, testimony, CM-GC, *Hearing before the Joint Standing Committee*, p. 10.

16. CM-BA, *Report on the Work of Extermination* (1895), p. 39.
17. Craig testimony, CM-GC, *Hearing before the Joint Standing Committee*, p. 11.
18. Quoted in Forbush and Fernald, *Gypsy Moth*, p. 33.
19. *Medford Mercury*, July 5, 1889, MED.
20. Hitchcock, "Professor Trouvelot's Mistake," pp. 1988–91.
21. "Portrait of William R. Sessions Given M. A. C.," *Springfield Republican*, May 11, 1921, UMA.
22. Mallis, *American Entomologists*, p. 123.
23. Fernald to Scudder, July 12, 1894, Scudder Correspondence, BSNH.
24. Sawyer, *To Make a Spotless Orange*, p. 137.
25. Mallis, *American Entomologists*, p. 146.
26. Ibid., p. 147.
27. Ibid, p. 142.
28. Howard, *Gipsy Moth in America*, p. 37.
29. Peters to unknown recipient, March 1963, Box 1, Folder 1, UMA.
30. Mallis, *American Entomologists*, p. 142.
31. Fernald to A. Agassiz, November 8, 1886, bBg 320–322, EML.
32. "Entomology and Zoology at the Massachusetts Agricultural College," pp. 5–9.
33. Alyokhin, "Short History of the Department."
34. Peters to unknown recipient, March 1963. Box 1, Folder 1, UMA.
35. Fernald to Haynes, September 17, 1900, Box 6, Folder 1, UMA.
36. Maria Fernald doubtless took her husband's place in his absence, since experiments with living insects could not otherwise have continued, although no records exist showing her in this capacity officially. Charles Fernald was a part-time entomologist of the station; his official position at Amherst was always professor of zoology. He was not able to devote himself principally to entomology until the appointment of R. S. Lull to the department of zoology as an assistant in 1896.
37. Fernald to Stetson, *Medford Mercury*, June 5, 1889, Box 6, Folder 1, UMA.
38. Fernald, Henry T., "Address to the Fernald Club," pp. 9–11.
39. Howard, *Gipsy Moth in North America*, p. 9.
40. Riley, "Importation of Ocneria Dispar," p. 86.
41. Fernald, "Notes on the Gypsy Moth," p. 60.
42. Fernald, "Dangerous Insect Pest in Medford," p. 4.
43. Fernald to Hagen, January 14, 1890, bMu 968.10.1, EML.
44. Fernald testimony, CM-GC, *Hearing before the Joint Standing Committee*, p. 6.
45. CM-BA, *Report on the Work of Extermination* (1893), p. 15.
46. Smith, Edward H., "Entomological Society of America," p. 13.
47. Howard, *History of Applied Entomology*, p. 109.
48. CM-BA, *Thirty-Fifth Annual Report* (1887), p. 78.
49. USDA, Proceedings *First Annual Meeting of the Association of Economic Entomologists*, p. 180.
50. Sorensen, *Brethren of the Net*, p. 86.
51. Howard, *History of Applied Entomology*, p. 106.
52. Riley to Hagen, October 27, 1883, BSNH.

53. Croker, *Stephen Forbes*, p. 119.
54. Burson, "United States 1890s," pp. 1–2.
55. Croker, *Stephen Forbes*, p. 102.
56. Sawyer, *To Make a Spotless Orange*, p. xix.
57. Fernald testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 49.
58. Fernald, "Notes on the Gypsy Moth," p. 60.
59. Fernald to Henshaw, September 12, 1889, bMu 968.10.2, EML.
60. Henshaw to Fernald, September 17, 1889, Box 8, Folder 209, UMA.
61. Fernald to Henshaw, September 20, 1889, bMu 968.10.2, EML.
62. Riley and Howard, "Imported Gypsy Moth," p. 209.
63. "Legislation against the Gypsy Moth," *Insect Life*, p. 150.
64. Letter to the Editor, *Garden and Forest*, November 20, 1889, p. 562.
65. CM, *Special Bulletin of the Hatch Experiment Station*, November 1889.
66. Fernald to Hagen, January 14, 1890, 968.10.1, EML.
67. Fernald to Henshaw, November 26, 1889, 968.10.2, EML.
68. Fernald, to Henshaw, November 30, 1889, 968.10.2, EML.
69. Ibid.
70. Mallis, *American Entomologists*, p. 123.

4. No Holiday Affair

1. Hagen to Fernald, January 15, 1890, EML.
2. Fernald to Hagen, January 14, 1890, bMu 968.10.1, EML.
3. Ibid.
4. Hagen to Fernald, January 15, 1890, EML.
5. Howard, *Fighting the Insects*, p. 47.
6. Ealand, *Insects and Man.*
7. Brackett in Henshaw, "Report upon the Gypsy Moth," p. 75.
8. Forbush and Fernald, *Gypsy Moth*, p. 264.
9. "About Town Matters in Arlington," p. 1.
10. J. W. Stockwell testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 415.
11. Howard, *History of Applied Entomology*, p. 116.
12. *Boston Evening Transcript,* May 15, 1890, p. 3.
13. Ward, "Agricultural Experiment Station," p. 68.
14. Fernald to Osborn, February 9, 1895, Box 8, Folder 213, UMA.
15. R. A. Duffy, personal communication with author, September 16, 2001.
16. Fernald to Henshaw, April 14, 1890, bMu 968.10.2, EML.
17. Lintner to Fernald, March 29, 1890, Box 8, Folder 199, UMA.
18. In Forbush and Fernald, *Gypsy Moth*, Fernald gives the date as March 22.
19. CM-BA, *Thirty-eighth Annual Report* (1890), p. 60.
20. Rawson to Fernald, March 30, 1890, Box 3, Folder 102, UMA.
21. J. G., Jack, Letter to the Editor, *Garden and Forest*, June 4, 1890, p. 277.
22. Lintner to Fernald, April 7, 1890, Box 8, Folder 199, UMA.

23. Ibid.
24. Henshaw to Fernald, April 11, 1890, Box 2, Folder 66, UMA.
25. Ibid.
26. Fernald to Henshaw, April 17, 1890, bMu 968.10.2, EML.
27. Baker and Heinton, "Traps Have Some Value," p. 407.
28. Forbush and Fernald, *Gypsy Moth*, p. 42.
29. Fernald quoted in letter to Henshaw, May 24, 1890, bMu 968.10.2, EML.
30. Ibid.
31. Riley and Howard, "Legislation against the Gipsy Moth," p. 78.
32. Lodeman, *Spraying of Plants*, p. 197.
33. Howard, *History of Applied Entomology*, p. 65.
34. Forbush and Fernald, *Gypsy Moth*, p. 159.
35. Henshaw, "Report upon the Gypsy Moth in Massachusetts," p. 77.
36. W. W. Fifield, testimony, CM-GC, *Hearing before the Joint Special Committee*, pp. 95–96.
37. Riley and Howard, "Experience with the Gipsy Moth," pp. 126–127.
38. CM-BA, *Report of the Board of Agriculture on Destroying the Gypsy Moth* (1893), p. 17.
39. Rogers and Burgess, *Report on the Field Work*, p. 11.
40. Brackett to Massachusetts Senate and House of Representatives, May 15, 1890, Record Series GO, vol. 107, MSA.
41. Fernald and Forbush, *Gypsy Moth*, give the total number as eighty-nine.
42. Riley and Howard, "Legislation against the Gipsy Moth," p. 78.
43. CM-BA, *Thirty-eighth Annual Report*, (1890), p. 62.
44. W. B. Harmon, CM, *Statements from Eye-Witnesses*.
45. Forbush and Fernald, *Gypsy Moth,* pp. 17–18.
46. Ibid., p. 15.
47. Riley and Howard, "Legislation against the Gipsy Moth," p. 79.
48. "Three Architectural Tours," p. 17.
49. Fernald to J. B. Smith, June 14, 1898, Box 3, Folder 117, UMA.
50. Shaler testimony, CM-GC, *Hearing before the Joint Standing Committee*, p. 3.
51. Fernald to Henshaw, December 8, 1890, bMu 968.10.2, EML.
52. Riley, "Outlook For Applied Entomology," p. 200.
53. Riley and Howard, "Efforts to Stamp Out the Gypsy Moth," p. 365.
54. CM-BA, *Thirty-eighth Annual Report* (1890), pp. xxii–xxiii.
55. Ibid., p. 59.
56. Ibid., p. 62.

5. Preparations for War

1. Shaler testimony, CM-GC, *Hearing before the Joint Special Committee*, pp. 318–19.
2. CM-BA *Minutes* (1891).
3. CM-GC, *Acts and Resolves*, 1890–91, p. 1152.

4. Russell to Shaler, February 7, 1891, Agency Code GO 1, Record Group 568X, Letters Official, 1861–1926, MSA.
5. Russell to Rawson, January 23, 1891, Agency Code GO 1, Record Group 568X, Letters Official, 1861–1926, MSA.
6. E. W. Wood testimony, CM-GC, *Hearing before the Joint Standing Committee*, p. 2.
7. Russell to Rawson, February 20, 1891, Agency Code GO 1, Record Group 568X, Letters Official, 1861–1926, MSA.
8. Russell to Executive Council of the Massachusetts State Legislature, February 25, 1891, Agency Code GO 1, Record Group 568X, Letters Official, 1861–1926, MSA.
9. CM-GC, *Acts and Resolves*, 1890–91, pp. 1150–52.
10. Wood testimony, CM-GC, *Hearing before the Joint Standing Committee*, pp. 1–2.
11. Shaler testimony, ibid., p. 12.
12. J. G. Jack, "Can the Gypsy Moth Be Exterminated?" *Garden and Forest*, March 11, 1891.
13. Hobbs, "Nathaniel Southgate Shaler," pp. 924–26.
14. Livingstone, *Nathaniel Southgate Shaler*, p. 47.
15. Shaler testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 325.
16. Howard, *History of Applied Entomology*, esp. p. 92.
17. E. H. Smith, personal exchange with author, 1998.
18. Howard, *History of Applied Entomology*, p. 92.
19. Lane Cooper, *Louis Agassiz as a Teacher*.
20. Howard, *History of Applied Entomology*, pp. 18–19.
21. Croker, *Stephen Forbes*, p. 42.
22. Livingstone, *Nathaniel Southgate Shaler*, p. 29.
23. Ibid., p. 167
24. G. Pinchot, *The Fight for Conservation, 1906*, in Livingstone, *Nathaniel Southgate Shaler*, p. 324.
25. Shaler testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 321.
26. Forbush and Fernald, *Gypsy Moth*, App. A, p. iii. See also "(Stenographic) Report of a Discussion on the Gypsy Moth." *Insect Life* 3, nos. 9 and 10 (1891): 368–81.
27. CM, *Special Bulletin of the Hatch Experiment Station*.
28. Forbush and Fernald, *Gypsy Moth*, App. A, p. iv.
29. Ibid.
30. Riley to Henshaw, October 28, 1889, bMu 2339.10.2, EML.
31. Riley to Henshaw, September 29, 1891, bMu 2339.10.2, EML.
32. Forbush and Fernald, *Gypsy Moth*, App. A, pp. v, xvi.
33. Ibid., pp. vii–viii.
34. Ibid., p. viii.
35. Ibid., p. xii.
36. Ibid., pp. v, xvi.

37. Riley, address to California State Board of Horticulture, Riverside, April 12, 1887, in Graham, *Dragon Hunters*, p. 22.
38. *The Nationalizing of American Life, 1877–1900*, ed. R. Ginger, p. 189.
39. Russell to Executive Council of the Massachusetts State Legislature, February 25, 1891, Agency Code GO 1, Record Group 568X, Letters Official, 1861–1926, MSA.
40. Forbush and Fernald, *Gypsy Moth, App. A*, pp. xv–xvi.
41. Ibid., p. xv.
42. Riley to Hagen, July 15, 1885, bMu 2339.10.1 (26)–(40), EML.
43. Scudder to Packard, June 6, 1881, bMu 2497.10.10–12, EML. See also Riley to Scudder, June 1, 1881, bMu 2339.10.4 (41)–(43)-2339.10.2, EML.
44. Scudder to Packard, May 29, 1881, bMu 2497.10.10–12, EML.
45. Forbush and Fernald, *Gypsy Moth*, App. A, pp. xvii–xviii.
46. Ibid., p. xiv.

6. The Moth Slayers

1. May, "Edward Howe Forbush," p. 40.
2. Letterheads in the Forbush folder, Special Collections, EML.
3. Henshaw, "Report upon the Gypsy Moth," p. 78.
4. CM-BA, [*Special*] *Report* (1891), p. 7.
5. Sorensen, *Brethren of the Net*.
6. R. T. Jackson, "Samuel Henshaw," in Mallis, *American Entomologists*, p. 459.
7. Winsor, *Reading the Shape of Nature*, p. 219.
8. Fernald testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 1107.
9. S. Henshaw, testimony, ibid., pp. 680–81.
10. May, "Edward Howe Forbush," p. 55.
11. E. H. Forbush, testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 1301.
12. Ibid. p. 1302.
13. CM-BA, [*Special*] *Report* (1891), pp. 8–9.
14. Forbush and Fernald, *Gypsy Moth*, p. 46.
15. May, "Edward Howe Forbush," p. 54.
16. Ibid., p. 55.
17. CM-BA, *Minutes* (1891), April 21, 1891.
18. *Nationalizing of American Life*, edited by R. Ginger. pp. 9–10.
19. Harvey to Fernald, *Gypsy Moth*, App. E, p. xlv.
20. Osgood, "State in Arms against a Caterpillar," p. 463.
21. "Rules and Regulations of the State Board of Agriculture," in Forbush and Fernald, *Gypsy Moth*, App. B, p. xxiii.
22. Forbush and Fernald, *Gypsy Moth*, pp. 51–52.
23. "Rules and Regulations of the State Board of Agriculture," in Forbush and Fernald, *Gypsy Moth*, App. B, p. xxiv.

24. "Communications," p. 123.
25. Ibid.
26. Forbush testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 1269.
27. Forbush and Fernald, *Gypsy Moth*, p. 54.
28. Ibid., p. 118.
29. Forbush testimony, CM-GC, *Hearing before the Joint Standing Committee*, p. 5.
30. Sessions to Fernald, March 16, 1891, Box 3, Folder 114, UMA.
31. CM-BA, [*Special*] *Report* (1891), p. 6.

7. Summer 1891

1. Forbush and Fernald, *Gypsy Moth*, App. C, p. xxviii.
2. Ibid., pp. xxviii–xxix.
3. CM-BA, [*Special*] *Report* (1891), p. 7.
4. L. Mansfield, CM, *Statements from Eye-Witnesses*.
5. Henshaw, "Report upon the Gypsy Moth," p. 80.
6. CM-BA, [*Special*] *Report* (1891), p. 7.
7. Forbush testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 315.
8. D. M. Rogers, testimony, CM-GC, *Hearing before the Joint Standing Committee*.
9. "Rules and Regulations of the State Board of Agriculture," in Forbush and Fernald, *Gypsy Moth*, App. B, p. xxv.
10. Lodeman, *Spraying of Plants*, p. 212.
11. "Communications," p. 123.
12. Henshaw, "Report upon the Gypsy Moth," pp. 79–80.
13. "Communications," p. 123.
14. Forbush and Fernald, *Gypsy Moth*, p. 56.
15. Riley to Henshaw, June 20, 1891, bMu 2339.10.2, EML.
16. Henshaw testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 684.
17. Henshaw, "Report upon the Gypsy Moth," p. 79.
18. Riley and Howard, "Extermination of the Gypsy Moth," p. 474.
19. Riley to Henshaw, June 20, 1891, bMu 2339.10.2, EML.
20. Henshaw, "Report upon the Gypsy Moth," p. 81.
21. Riley to Henshaw, June 29, 1891, bMu 2339.10.2, EML.
22. Riley to Henshaw, July 10, 1891, bMu 2339.10.2, EML.
23. Riley, *Address to the Massachusetts Horticultural Society*.
24. Riley and Howard, "Extermination of the Gypsy Moth," p. 474.
25. *Special Report of the State Board of Agriculture* (1891), p. 17.
26. Fernald testimony, CM-GC, *Hearing before the Joint Special Committee*, pp. 50–51.
27. Ibid., p. 82.
28. Riley and Howard, "Japanese Parasite of the Gypsy Moth," p. 227.
29. Riley to Fernald, July 23, 1891, Box 8, Folder 220, UMA.

30. Ibid.
31. Fernald to J. H. Bowditch, February 5, 1904, Box 6, Folder 1, UMA.
32. Riley to Henshaw, July 10, 1891, bMu 2339.10.2, EML.
33. Forbush and Fernald, *Gypsy Moth*, p. 209.
34. Forbush, "Birds Useful to Agriculture," p. 47.
35. Henshaw, "Report upon the Gypsy Moth," p. 79.
36. "The Dangers of Arsenical Poisoning Resulting from Spraying with Insecticides," in Forbush and Fernald, *Gypsy Moth*, App. F, p. lxv.
37. Sessions to Fernald, August 10, 1891, Box 3, Folder 114, UMA. The initials "H. S." almost certainly stand for "History Society," since many of the opposing entomologists were members of the Boston Natural History Society.
38. Riley to Henshaw, September 29, 1891, bMu 2339.10.2, EML.
39. Osgood, "Gypsy Moth in Massachusetts," p. 678.
40. Ibid.
41. CM-BA, [*Special*] *Report* (1891), p. 10.
42. Sessions testimony, CM-GC, *Hearing before the Joint Standing Committee*, p. 4.

8. The Cyclone Burner

1. Riley, *Address to the Massachusetts Horticultural Society*.
2. Riley to Henshaw, February 18, 1892, bMu 2339.10.2, EML.
3. Forbush and Fernald, *Gypsy Moth*, p. 62.
4. Fernald testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 52.
5. Sessions to Fernald, January 26, 1896, Box 3, Folder 114, UMA.
6. CM-BA, *Report on the Work of Extermination* (1892), p. 13.
7. Ibid., p. 9.
8. Ibid., p. 18.
9. CM-BA, *Fortieth Annual Report*, (1892), p. 264.
10. CM-BA, [*Special*] *Report* (1891), p. 15.
11. "Letter," p. 99.
12. Ibid.
13. S. R. Huston testimony, CM-CG, *Hearing before the Joint Standing Committee*, p. 13.
14. Forbush and Fernald, *Gypsy Moth*, p. 63.
15. In the terminology of Fernald's time, molds and fungi were both considered vegetative matter with parasitic effects on their hosts; later they would be called disease pathogens.
16. Glaser, "Wilt of Gypsy Moth Caterpillars," p. 101. Diseases were also considered parasitic at the time.
17. Fernald, "Notes on the Gypsy Moth," p. 61.
18. Riley and Howard, "Further Notes on the Japanese Gypsy Moth and Its Parasites," p. 195.
19. Osgood, "State in Arms against a Caterpillar," p. 460.
20. Fernald, "Notes on the Gypsy Moth," p. 62. "Tophet" is apparently an anglicized

version of a Jewish term for a particularly unpleasant and painful condition or place and derives from the Hebrew word *topet*, a place where children were burned (*American Heritage Dictionary of the English Language*, Third Edition).

21. J. H. Bowditch testimony, CM-GC, *Hearing before the Joint Special Committee,* p. 479.
22. L. Goddu, CM, *Statements from Eye-Witnesses.*
23. A. R. Bunting, ibid.
24. CM-BA, *Fortieth Annual Report* (1892), p. 274.
25. Ramsey, "Notes on the Discovery of Lead Arsenate."
26. Ward, "Agricultural Experiment Station," p. 68.
27. R. A. McCarty, CM, *Statements from Eye-Witnesses.*
28. M. M. Ransom, ibid.
29. CM-BA, *Report on the Work of Extermination* (1892), pp. 6–7.
30. CM-BA, *Fortieth Annual Report* (1892), p. 297.
31. Ibid., p. 276.
32. CM-BA, *Report on the Work of Extermination* (1892), p. 19.
33. Forbush and Fernald, *Gypsy Moth*, p. 65.
34. CM-BA, *Report on the Work of Extermination* (1892), p. 21.
35. Forbush and Fernald, *Gypsy Moth*, p. 101.
36. "Short History of the MDC" (in 1919 the name was changed to the "Metropolitan District Commission").
37. "Members of the First Metropolitan Commission," App. B, p. 32.

9. Lead, Arsenic, Burlap, and Fire

1. CM-GC, *Acts and Resolves 1896*, p. 672.
2. CM-BA, *Report on the Work of Extermination* (1893), p. 35.
3. Caesar, "Fifty Years of Entomological Progress, Part II," p. 12.
4. Moulton to Fernald, undated, Folder 209, UMA.
5. Fernald, "Notes on the Gypsy Moth," p. 61.
6. CM-GC, *Acts and Resolves* 1892–93, pp. 1486–87.
7. CM-BA, *Report on the Work of Extermination* (1893), p. 5.
8. CM-GC, G. W. Creesy, *Statements from Eye-Witnesses.*
9. CM-BA, *Report on the Work of Extermination* (1893), p. 20.
10. Forbush and Fernald, *Gypsy Moth*, p. 193.
11. Ibid.
12. Forbush testimony, CM-GC, *Hearing before the Joint Standing Committee*, p. 7.
13. Riley and Howard, "Gypsy Moth in Cambridge," p. 53.
14. Riley and Howard, "Parasite of the Japanese Gypsy Moth," p. 335.
15. CM-BA, *Report on the Work of Extermination* (1893), p. 5.
16. S. R. Huston testimony, CM-GC, *Hearing before the Joint Standing Committee*, p. 15.

17. B. R. Hennelly testimony, ibid., p. 632.
18. CM-BA, *Report on the Work of Extermination* (1893), pp. 30–31.
19. Ibid., p. 9.
20. Ibid., p. 20.
21. Ibid., p. 34.
22. Ward, A. B., "Agricultural Experiment Station," p. 68.
23. CM, *Report of the Board of World's Fair Managers*, pp. 59–60.
24. Sessions to Fernald, October 27, 1893, Box 8, Folder 223, UMA.
25. Sessions to Fernald, November 1, 1893, Box 8, Folder 223, UMA.
26. Shaler to Fernald, November 1, 1893, Box 109, Folder 221, UMA.
27. Shaler to Fernald, November 15, 1893, Box 109, Folder 221, UMA.
28. Sessions to Fernald, May 31, 1893. Box 3, Folder 114, UMA.
29. Joseph A. Lintner, "Our Insect Enemies and How to Meet Them." address to the New Jersey Board of Agriculture, Trenton, N.J., February 1, 1889.
30. Fernald to Osborn, February 9, 1894, Box 8, Folder 213, UMA.
31. Lintner to Fernald, June 22, 1893, App. D, Forbush and Fernald, *Gypsy Moth*.
32. Lintner to Fernald, June 2, 1893, Box 8, Folder 199, UMA.
33. J. B. Smith to Fernald, June 20, 1893, App. D in Forbush and Fernald, *Gypsy Moth*.
34. Henry T. Fernald to Fernald, June 19, 1893, App. D in ibid.
35. Packard to Fernald, June 19, 1893, App. D in ibid.
36. Sessions to Fernald, June 6, 1893, Box 3, Folder 114, UMA.
37. Riley to Henshaw, November 3, 1893, bMu 2339.10.2, EML.

10. Rebounds and Resignations

1. Goodwin testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 245.
2. CM-BA, *Minutes* (1893).
3. Goodwin testimony, CM-GC, *Hearing before the Joint Standing Committee*, p. 9.
4. F. H. Appleton testimony, ibid., p. 7.
5. Fernald, testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 58.
6. CM-BA, *Minutes* (1894), July 26, 1894.
7. May, "Edward Howe Forbush," p. 55.
8. CM-BA, *Report on the Work of Extermination* (1894), p. 18.
9. Fernald, "Notes on the Gypsy Moth," p. 66.
10. W. C. Wright, CM-GC, *Hearing before the Joint Standing Committee*, p. 3.
11. O. J. McCarthy, testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 515.
12. Howard, *Gipsy Moth in America*, p. 16.
13. CM-BA, *Report on the Work of Extermination* (1894), p. 27.
14. Sessions to Fernald, May 29, 1894, Box 8, Folder 223, UMA.
15. Caesar, "Fifty Years of Progress in Entomology, Part II," p. 16.

16. Perkins to Fernald, July 1894, App. E in Forbush and Fernald, *Gypsy Moth*.
17. I. J. Colbert, testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 596.
18. Comstock to Sessions, July 17, 1894, App. E in Forbush and Fernald, *Gypsy Moth*.
19. Ibid.
20. Harvey to Fernald, July 1894, App. E in ibid.
21. Ibid.
22. Ibid.
23. Fernald testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 73.
24. Lintner, *Report of the New Jersey State Board of Agriculture, 1893–4*, pp. 55–56.
25. Lintner, "Address to the New Jersey Board of Agriculture."
26. Howard, "A Brief Account of the Rise and Present Condition of Official Economic Entomology," p. 59. In *The Gypsy Moth*, Appendix E, p. l.
27. Ibid.
28. Fernald testimony, CM-GC, *Hearing before the Joint Special Committee*, pp. 54–55.
29. Frederick Law Olmsted to his partners, October 28, 1893, in Morgan, "Charles Eliot," p. 13.
30. CM-BA, *Report on the Work of Extermination* (1894), p. 16.
31. Carruth to Forbush, March 29, 1894, Agency Code EN4, MDC, Record Series 1055X, MSA.
32. CM-MPC, *Report* (1894): "Landscape Architects' Report."
33. Haglund, "Emerald Metropolis," p. 10.
34. CM-BA, *Report on the Work of Extermination* (1894), p. 17.
35. Forbush and Fernald, *Gypsy Moth*, App. A, p. viii.
36. Fernald, "Notes on the Gypsy Moth," p. 64.
37. Forbush and Fernald, *Gypsy Moth*, p. 474.
38. Ibid., p. 95.
39. CM-BA, [*Special*] *Report* (1891), p. 21.
40. Forbush and Fernald, *Gypsy Moth*, p. 60, 62.

11. Unusual Business

1. CM-BA, *Minutes* (1894), July 26, 1894.
2. Riley to Henshaw, November 2, 1893, bMu 2339.10.2, EML.
3. Mallis, *American Entomologists*, p. 78.
4. Fernald to Osborn, February 9, 1894, Box 8, Folder 213, UMA.
5. Fernald to Osborn, February 9, dated 1894, Box 8, Folder 213, UMA. Fernald's date on this letter is incorrect, since the events mentioned did not occur until 1895.
6. A. E. Barker testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 793.
7. Fernald, "Notes on the Gypsy Moth," p. 66.
8. Ibid., p. 64.

9. CM-BA, *Report on the Work of Extermination* (1895), p. 1.
10. Forbush to Fernald, June 29, 1895, Box 7, Folder 176, UMA.
11. Ibid.
12. CM-BA, *Report on the Work of Extermination* (1895), p. 42.
13. Ibid.
14. Howard, *Gipsy Moth in America*, p. 21.
15. Fernald, "Evolution of Economic Entomology," p. 10.
16. Forbush testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 1094.
17. Forbush and Fernald, *Gypsy Moth*, pp. 287–88.
18. Fernald to Uhler, November 10, 1894, bMu 968.10.3–968.10.7, EML.
19. Hennelly testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 703.
20. Marlatt to Fernald, September 17, 1895, Box 8, Folder 204, UMA.
21. Fernald, "Notes on the Gypsy Moth," p. 61.
22. Riley to Scudder, May 9, 1894, Scudder Correspondence, Riley folder VI, BSNH.
23. L. W. Ross testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 458.
24. J. A. Bailey Jr., testimony, ibid., pp. 767–69.
25. Ibid., p. 70.
26. Ward, "Agricultural Experiment Station," p. 74.
27. Fernald, "Notes on the Gypsy Moth," p. 63.
28. Ibid.
29. Fernald to Scudder, April 28, 1896, Scudder Correspondence, BSNH.
30. Ibid.

12. The Politics of War

1. CM-BA, *Report on the Work of Extermination* (1896), p. 6.
2. Sessions to Fernald, January 22, 1896, Box 3, Folder 114, UMA.
3. Howard, Presidential Address.
4. Sessions testimony, CM-GC, *Hearing before the Joint Standing Committee*, p. 14.
5. Fernald testimony, ibid., p. 6.
6. W. Frost testimony, ibid., p. 6.
7. Forbush testimony, ibid., pp. 7–8.
8. Ibid., p. 17.
9. Fernald testimony, ibid., p. 18.
10. V. Frost testimony, ibid., p. 17.
11. Ibid.
12. Ibid., p. 19.
13. W. Frost testimony, ibid., p. 24.
14. Ibid.
15. Kirkland to Fernald, February 1, 1896, Box 2, Folder 72, UMA.
16. Kirkland to Fernald, February 6, 1896, Box 2, Folder 72, UMA.
17. Forbush to Fernald, February 5, 1896, Box 1, Folder 47, UMA.

18. Howard to Fernald, February 10, 1896, Box 8, Folder 181, UMA.
19. Howard to Fernald, February 11, 1896, Box 8, Folder 181, UMA.
20. Kirkland to Fernald, February 20, 1896, Box 2, Folder 72, UMA.
21. Forbush testimony, CM-GC, *Hearing before the Joint Standing Committee*, p. 7.
22. Appleton testimony, ibid., p. 7.
23. Scudder testimony, ibid., pp. 2–3.
24. Kirkland to Fernald, February 27, 1896, Box 2, Folder 72, UMA.
25. Ibid.
26. Goodwin testimony, CM-GC, *Hearing before the Joint Standing Committee*, p. 245.
27. Shaler testimony, ibid., p. 2.
28. Ibid.
29. Bailey testimony, *Hearing before the Joint Special Committee*, p. 771.
30. Forbush to Fernald, February 26, 1896, Box 1, Folder 47, UMA.
31. Sessions to Fernald, February 28, 1896, Box 3, Folder 114, UMA.
32. Kirkland to Fernald, February 28, 1896, Box 2, Folder 72, UMA.
33. Forbush testimony, *Hearing before the Joint Standing Committee*, p. 11.
34. Howard to Forbush, in ibid., p. 3.
35. Kirkland to Fernald, March 6, 1896, Box 2, Folder 72, UMA.
36. McCarthy testimony, *Hearing before the Joint Special Committee*, p. 514.
37. Hennelly testimony, ibid., p. 691.
38. Kirkland to Fernald, March 10, 1896, Box 2, Folder 72, UMA.
39. Kirkland to Fernald, March 7, 1896, Box 2, Folder 72, UMA.
40. Fowler to Fernald, February 27, 1896, Box 2, Folder 72, UMA.
41. Kirkland to Fernald, March 21, 1896, Box 2, Folder 72, UMA.
42. Kirkland to Fernald, April 23, 1896, Box 2, Folder 72, UMA.
43. CM-BA, *Report on the Work of Extermination* (1896), p. 18.
44. CM-House, *Report of the Special Committee*, *House Document No. 1138*, p. 6.
45. Fernald to Uhler, May 25, 1896, bMu 988.10.3–968.10.7, EML.
46. Fernald to Scudder, June 8, 1896, Scudder Correspondence, BSNH.
47. Sessions to Fernald, June 3, 1896, Box 3, Folder 114, UMA.
48. Barker testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 743.
49. CM-House, *Debate*, p. 2.
50. Kirkland to Fernald, June 29, 1896, Box 8, Folder 195, UMA.
51. Sessions testimony, *Hearing before the Joint Standing Committee*, pp. 8–9.
52. Wood to Fernald, September 30, 1896.
53. Kirkland to Fernald, August 12, 1896, Box 2, Folder 72, UMA.
54. John B. Smith, *Economic Entomology*, p. 271.
55. CM-BA, *Report on the Work of Extermination* (1896), p. 38.
56. Ibid., p. 14.
57. Kirkland to Fernald, December 23, 1896, Box 2, Folder 72, UMA.
58. Fernald to Scudder, June 8, 1896, Scudder Correspondence, BSNH.
59. Ealand, *Insects and Man*, p. 68.
60. Kirkland to Fernald, October 19, 1896, Box 2, Folder 72, UMA.

13. A Moth Too Many

1. CM-BA, *Report on the Work of Extermination* (1897), p. 9.
2. CM-House, *Debate*, p. 7.
3. Ibid., p. 1.
4. Fernald to *Boston Advertiser*, February 2, 1899.
5. Mallis, *American Entomologists*, p. 315.
6. Ibid.
7. CM-BA, *Report on the Work of Extermination* (1897), p. 15.
8. Osgood, "State in Arms against a Caterpillar," p. 458.
9. Ibid., p. 459.
10. "Cost of Fighting a Pest."
11. Woodbury to Forbush, April 7, 1897, Agency Code EN4, MDC, Record Series 1055X, Book 7, MSA.
12. Kirkland to Fernald, May 4, 1897, Box 2, Folder 72, UMA.
13. Osgood, "State in Arms against a Caterpillar," p. 682.
14. Kirkland to Fernald, May 22, 1897, Box 2, Folder 72, UMA.
15. Kirkland, "Report to the Massachusetts Horticultural Society," 1902, in Fernald and Kirkland, *Brown-tail Moth*, p. 11.
16. Fernald and Kirkland, *Brown-tail Moth*, p. 17.
17. Ibid., p. 21.
18. Ibid., p. 32.
19. Ibid., pp. 35–36.
20. Kirkland to Fernald, July 6, 1897, Box 2, Folder 72, UMA.
21. Kirkland to Fernald, July 19, 1897, Box 2, Folder 72, UMA.
22. Kirkland to Fernald, August 4, 1897, Box 2, Folder 72, UMA.
23. Kirkland, "On the Preparation of Arsenate of Lead," pp. 46–48.
24. Forbush and Fernald, *Gypsy Moth*, p. 162.
25. Kirkland, "Danger from the Use of Lead Arsenate," p. 91.
26. F. J. Smith to Fernald, June 13, 1899, Box 8, Folder 221, UMA.
27. Whorton, *Before Silent Spring*, p. 41.
28. Ibid. pp. 36–67, 81–82.
29. Webster, "Present and Future of Applied Entomology," p. 9.
30. Howard, *Gipsy Moth in America*, pp. 24, 30, 35, 37.
31. Ibid., pp. 22–24.
32. Kirkland to Fernald, November 10, 1897, Box 2, Folder 72, UMA.
33. CM-BA, *Report on the Work of Extermination* (1897), pp. 13, 18.
34. Ibid., p. 15.
35. Ibid., p. 45.
36. Ibid., p. 50.

14. Do or Die

1. *Sixteenth Annual Report of the Maine Agricultural Experiment Station*, pp. 35–36.
2. Ibid., p. 36.
3. John B. Smith, "Germany's Exclusion of American Fruits," p. 432.
4. Fernald to Henry T. Fernald, April 20, 1898, Box 6, Folder 1, UMA.
5. Kirkland to Fernald, January 3, 1898, Box 2, Folder 72, UMA.
6. T. C. Lyford testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 722.
7. Kirkland to Fernald, February 15, 1898, Box 2, Folder 72, UMA.
8. Kirkland to Fernald, March 17, 1898, Box 2, Folder 72, UMA.
9. "Scientific News," p. 385.
10. CM-BA, *Forty-Sixth Annual Report* (1898), p. 412.
11. Kirkland to Fernald, April 21, 1898, Box 2, Folder 72, UMA.
12. Woodbury to Forbush, April 7, 1898, Agency Code EN4 (MDC), Record Series 1055X, Book 8, MSA.
13. Howard, *Gipsy Moth in America*, p. 18.
14. CM-BA, *Forty-Sixth Annual Report* (1898), p. 463.
15. Osgood, "State in Arms against a Caterpillar," p. 462.
16. Forbush, "Recent Work of the Gypsy Moth Committee," p. 80.
17. CM-BA, *Forty-Sixth Annual Report* (1898), p. 431.
18. Howard to Fernald, November 7, 1898, Box 8, Folder 181, UMA.
19. Osgood, "Gypsy Moth in Massachusetts," p. 681.
20. L. W. Ross testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 454.
21. A. E. Barker testimony, ibid., pp. 804–5.
22. Forbush to Fernald, November 30, 1898, Box 7, Folder 176, UMA.
23. CM-BA, *Forty-Sixth Annual Report* (1898), p. 416.
24. W. C. Wright testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 634.
25. CM-BA, *Forty-Sixth Annual Report* (1898), p. 433.
26. Fernald to Dyar, September 15, 1898, Box 6, Folder 1, UMA.
27. Kirkland to Fernald, September 25, 1898, Box 2, Folder 72, UMA.
28. Howard to Fernald, November 7, 1898, Box 8, Folder 181, UMA.
29. CM-MPC, [Seventh] *Annual Report* (1898), pp. 33–34.
30. Ibid., pp. 51–52.
31. Bowker to Fernald, October 21, 1898, Box 1, Folder 9, UMA.
32. CM-BA, *Forty-Sixth Annual Report* (1898), p. 8.
33. Kirkland to Fernald, December 31, 1898 (1), Box 8, Folder 195, UMA.
34. Fernald to Dyar, December 19, 1898, Box 6, Folder 1, UMA.
35. Kirkland to Fernald, December 31, 1898 (2), Box 8, Folder 195, UMA.

15. Failure Is Not an Option

1. Kirkland to Fernald, January 4, 1899, Box 8, Folder 195, UMA.
2. CM-BA, *Forty-Sixth Annual Report* (1898), pp. 416, 422.
3. Ibid.
4. Roger Wolcott, "Governor's Inaugural Address," January 5, 1899, in CM-GC, *Acts and Resolves*, 1899.
5. Kirkland to Fernald, January 18, 1899, Box 8, Folder 195, UMA.
6. Ross testimony, *Hearing before the Joint Special Committee*, p. 460.
7. "Editorial Comment," p. 389.
8. Ross testimony, *Hearing before the Joint Special Committee*, p. 453.
9. USDA, *Proceedings of the Eleventh Annual Meeting of the Association of Economic Entomologists*, p. 105.
10. CM-BA, *Forty-Seventh Annual Report* (1899), p. 366.
11. Ibid., p. 367.
12. Osgood, "Gypsy Moth in Massachusetts," p. 688.
13. J. S. Pray testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 273.
14. Ibid., p. 274.
15. C. W. Brown testimony, ibid., p. 1202.
16. Wright testimony, ibid., p. 632.
17. J. A. Farley testimony, ibid., p. 585.
18. Forbush and Fernald, *Gypsy Moth*, p. 96.
19. CM-BA, *Report on the Work of Extermination* (1897), p. 26.
20. I. J. Colbert testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 590.
21. *Sixteenth Annual Report of the Maine Agricultural Experiment Station*, p. 37.
22. Fernald and Kirkland, *Brown-tail Moth*, p. 49.
23. Kirkland to Fernald, in Fernald, "Brown-tail Moth," p. 29.
24. F. J. Smith to Fernald, June 13, 1899, Box 8, Folder 221, UMA.
25. Kochi to Fernald, July 15, 1899, Box 8, Folder 192, UMA.
26. USDA, *Proceedings of the Eleventh Annual Meeting of the Association of Economic Entomologists*, p. 107.
27. Ibid., p. 6.
28. CM, *Special Bulletin of the Hatch Agricultural Experiment Station* (1899).
29. USDA, *Proceedings of the Eleventh Annual Meeting of the Association of Economic Entomologists,* p. 21.
30. Forbush testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 408.
31. Crosby testimony, ibid., p. 914.
32. Ibid.
33. Osgood, "Gypsy Moth in Massachusetts," p. 684.
34. Seaburg and Seaburg, *Medford on the Mystic*, p. 53.
35. Wambaugh, "Present Scope of Government," p. 121.
36. CM-BA, *Forty-Seventh Annual Report* (1899), p. 349.

37. Howard and Fiske, *The Importation into the U. S. of the Parasites of the Gipsy Moth and the Brown-tail Moth*, p. 49.
38. J. G. Avery testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 291.
39. May, "Edward Howe Forbush," p. 46.
40. McCarthy testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 519.
41. Ibid., p. 514.
42. Fernald to Howard, October 21, 1899, Box 6, Folder 1, UMA.
43. Fernald to W.A.H., March 7, 1900, Box 6, Folder 1, UMA.
44. CM-BA, *Forty-Seventh Annual Report* (1889).
45. CM-BA, *Minutes* (1899), December 8, 1899.

16. The Last Hurrah

1. CM-BA, *Minutes* (1900).
2. R. W. Marshall testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 490.
3. CM-BA, *Forty-Eighth Annual Report* (1900), p. 357.
4. CM-House, *Report of the Special Committee*, *House Document No. 1138*, p. 2.
5. Barker testimony, CM-GC *Hearing before the Joint Special Committee*, pp. 804–5.
6. Fernald testimony, ibid., p. 51.
7. Ross testimony, ibid., p. 452.
8. Fernald testimony, ibid., p. 1103.
9. Barker testimony, ibid., p. 805.
10. CM-House, *Report of the Special Committee*, *House Document No. 1138*, p. 4.
11. Forbush to Fernald, March 5, 1900, Box 8, Folder 195, UMA. This letter on the board's letterhead states that scouting parties had not found any brown-tail moths in New Hampshire.
12. Spooner to Massachusetts agriculture secretary, December 19, 1899, Box 8, Folder 195, UMA.
13. Fernald to Howard, January 8, 1900, Box 8, Folder 181, UMA.
14. Felt to Fernald, March 31, 1900, Box 7, Folder 173, UMA.
15. CM-House, *Report of the Special Committee*, *House Document No. 1138*, pp. 4–5.
16. Ibid., p. 5.
17. Crosby testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 899.
18. CM-House, *Report of the Special Committee*, *House Document No. 1138*, p. 10.
19. Ibid., pp. 8–9.
20. J. F. Toole testimony, CM-GC, *Hearing before the Joint Special Committee,* p. 737.
21. R. Hoffman testimony, ibid., p. 1428.

22. CM-House, *Report of the Special Committee, House Document No. 1138*, p. 11.
23. Ibid., p. 12.
24. Ibid., pp. 12–13.
25. Ibid., p. 24.
26. Ibid.
27. Crosby testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 902.
28. Ibid.
29. Kirkland testimony, ibid., p. 1414.
30. Ibid.
31. W. T. Sedgwick testimony, ibid., p. 1068.
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34. Ibid.
35. Henshaw testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 682.
36. Weed to Fernald, January 24, 1894, Box 8, Folder 234, UMA.
37. Osborn, H., "Presidential Address to the Tenth Annual Meeting of the Association of Economic Entomologists," pp. 9–10.
38. Fernald to Howard, February 10, 1900, Box 6, Folder 1, UMA.
39. Fernald to C. R. Osten-Sacken, June 24, 1902, Box 6, Folder 1, UMA.
40. Kirkland testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 1416.
41. Fernald testimony, ibid., p. 1072.
42. Ibid., p. 1083.
43. Forbush testimony, ibid., p. 1268.
44. Ibid., pp. 1303–5.
45. CM-BA, *Forty-Eighth Annual Report* (1900), pp. 366–67.
46. Osgood, "Gypsy Moth in Massachusetts," p. 677.
47. CM-BA, *Forty-Eighth Annual Report* (1900), p. 367–68.
48. CM-BA, *Forty-Ninth Annual Report* (1901), p. 4.
49. Ibid., p. 6.
50. CM-GC, *Acts and Resolves* 1901, p. 295.
51. Marlatt, "Fifty Years of Entomological Progress, Part I," p. 13.
52. Fernald to Howard, April 13, 1903, Box 6, Folder 1, UMA.
53. Kirkland to Fernald, January 20, 1899, Box 8, Folder 195, UMA.
54. Osgood, "Gypsy Moth in Massachusetts," p. 688.
55. Forbush and Fernald, *Gypsy Moth*, p. 215.
56. Howard, Presidential Address, p. 59.
57. Fernald testimony, CM-GC, *Hearing before the Joint Standing Committee*, n.p.
58. Shaler, *Autobiography*, pp. 396–97. There is no surviving record of Shaler as a park commissioner, and archived documents of the Metropolitan District Commission confirm that he never served on the MDC board.
59. Fernald to Bowditch, February 5, 1904, Box 6, Folder 1, UMA.

60. May, "Edward Howe Forbush," p. 55.
61. Osborn, "Duty of Economic Entomology," p. 7.
62. Ibid.

Epilogue

1. USDA, *Proceedings of the Fifteenth Annual Meeting of the Association of Economic Entomologists*, p. 56.
2. Forbush testimony, CM-GC, *Hearing before the Joint Special Committee*, p. 1303.
3. CM-BA, *Report of the Board of Agriculture on Extermination of the Gypsy Moth* (1901), p. 6.
4. Ibid., p. 7.
5. Fiske, *Parasites of the Gypsy and Brown-Tail Moths*, p. 12.
6. Howard and Fiske, *The Importation into the U.S. of the Parasites of the Gipsy Moth and the Brown-tail Moth*, p. 14.
7. Ibid., p. 221.
8. Ibid., p. 225.
9. Ibid., p. 221.
10. "Appropriation to Fight the Moth," p. 12.
11. "The Parasite Element of Natural Control," p. 411.
12. "The Present Status of Biological Control Work in California," p. 294.
13. Howard and Fiske, *The Importation into the U.S. of the Parasites of the Gipsy Moth and the Brown-tail Moth*, p. 5.
14. Ibid.
15. Howard, "Explorers of a New Kind," pp. 38–67.
16. Carson, *Silent Spring*, p. 11.
17. Hornaday, *Our Vanishing Wildlife*, p. 330.
18. *Twenty-Fifth Annual Report of the Massachusetts Agricultural Experiment Station*, pp. 81–84.
19. Sanderson, *Insect Pests of Farm, Garden, and Orchard*, pp. 5–6.
20. Forbush testimony, *Hearing before the Joint Standing Committee*, p. 7.
21. Burgess, "Report on the Gipsy Moth Work in New England."
22. Burgess, "Value to Uninfested States of Gypsy Moth Control," p. 559.
23. Ibid.
24. Turner, "Entomology in Connecticut," p. 35.
25. Weiss, H. B., *New Jersey Department of Agriculture*, p. 168.
26. *Fourteenth Annual Report of the Massachusetts State Forester*, p. 11.
27. CM-BA, *Fifty-Ninth Annual Report*, p. 291.
28. Burgess, "Recent Work in Control of Gypsy Moth and Brown-tail Moth," p. 774.
29. Burgess, "Gipsy Moth Work West of the Connecticut River," p. 585.
30. "Gipsy Moth Barrier Zone Maintenance Problem," p. 721.
31. Large portions of the same general area were redesignated as a "suppression zone" after World War II and finally abandoned in the 1960s.

32. Russell, *War and Nature*.
33. Weseloh, "People and the Gypsy Moth," p. 183.
34. Messenger and Popham, "From 0 to 5,000 in 34 Years," p. 251.
35. Todd and McGregor, "Insecticides and Bees," p. 131.
36. Bruce, "Insecticides and Flies," p. 326.
37. Corliss, "Gypsy Moth," p. 698.
38. Carson, *Silent Spring*, p. 258.
39. Weseloh, "People and the Gypsy Moth," p. 183.
40. Graham, *Dragon Hunters*, pp. 103–5.
41. Carson, *Silent Spring*, p. 161.
42. Russell, *War and Nature*, p. 214.
43. Waggoner, Paul E., "James Gordon Horsfall," p. 204. See also http://www.books.nap.edu/books/; and "Neely Turner 1901–1989," *American Entomologist*, p. 170.
44. Carson, *Silent Spring*, p. 158.
45. Ibid., p. 160.
46. Russell, *War and Nature*, p. 221.
47. Ibid., pp. 216–18.
48. Gore, introduction to 1994 printing of *Silent Spring*, p. xix.
49. Kegg, "Realities of the Gypsy Moth Problem," p. 154.
50. *Forest Pest Control*, pp. 114–15.
51. Ibid., p. 155.
52. The definition of "defoliation" is rather loose. It implies total leaf loss, but more likely refers to lesser degrees of damage. Tree "defoliation" does not necessarily equate with tree mortality.
53. Hajek, "Entomophaga maimaiga," p. 1. See also http://www.nysaes.cornell.edu/ent/bcconf/talks/hajek.html.
54. Fosbroke and Hicks, *Coping with the Gypsy Moth*, p. 2.
55. Imported predator insects are also thought to have completely dominated the satin moth (*Stilnoptia salcis*), a foreign insect, closely related to the gypsy and brown-tail moths, that was brought into Massachusetts around the turn of the nineteenth century.
56. Hajek, "Entomophaga maimaiga," p. 2.
57. Author's personal observations from gypsy moth informational meetings held in Maryland during the early 1990s.
58. *Eradication of Exotic Pests*, p. 230.
59. Gansner et al., "Tracking Changes in the Susceptibility of Forest Land Infested with Gypsy Moth."
60. Bailey, "Natural Checks," p. 191.

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